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## *THE SALARIES OF PROFESSORS IN AMERICAN COLLEGES AND UNIVERSITIES*[1]

THE Carnegie Foundation for the Advancement of Teaching, in seeking to carry out its primary object of establishing a retiring allowance system in the colleges, universities, and technical schools of the United States, the Dominion of Canada, and Newfoundland, has found it necessary to conduct various enquiries into the condition of education in these three countries. Among the first of these studies was one which had to do with the salary and tenure of office of the professor and of other officers of instruction. The results of that study are given in the present bulletin and are based upon data supplied by some seven hundred and fifty institutions in the United States and Canada, the figures given in all cases being presented exactly as they were received from the officers of these institutions.

The organization of colleges and universities in the United States is fashioned very much after that of business corporations; the board of trustees corresponding to the board of directors, the chairman of the board to the chairman of the board of directors, the president of the college to the general manager. The president is the connecting link between the administrative body of trustees on the one side and the teaching body on the other.

[1] From Bulletin number two of the Carnegie Foundation for the Advancement of Teaching. This bulletin, entitled "The Financial Status of the Professors in America and in Germany," contains much additional information and discussion.

In Canada the organization is somewhat more democratic, the governing boards in most cases being elected from the alumni and containing generally members of the faculty.

The instructing staff in most institutions, both in the United States and Canada, consists of professors, associate professors, and assistant or adjunct professors. These form the faculty or permanent body of teachers. In addition there are grades of instructors, lecturers, tutors and assistants whose positions are in great or less measure temporary.

Not all of these offices appear in all institutions. Even in some of the larger universities there are only two grades in the faculty, the professor and assistant or adjunct professor. In many smaller colleges the greater part of the teaching staff is included in the faculty with a very limited number of instructors and assistants. The grade of preceptor is unique in Princeton, where its holders are considered of faculty rank.

While this paper will deal, so far as seems necessary to render clear the status of the professor, with all of these grades of the instructing staff, it is upon the holder of the professorial title as embodying the force and tradition of college teaching that the attention will be principally directed.

As was pointed out in the second annual report of the president of the foundation, the words "college" and "university" have no well settled meaning in America, nor is the sphere of higher education by any means carefully defined. As a result the degree-giving institutions in these countries present every variety of educational and administrative complexity. Even the well-informed educator is apt to speak of our colleges and universities as if they formed a homogeneous species conforming more or less clearly to some typical condition. Not only is this not the fact, but these institutions do not even fall into any definite number of such species. There is no method of classification which, when applied to the thousand American and Canadian degree-conferring institutions, will enable the student to divide them into clear species. Whatever criterion is chosen will result in placing some institutions in company to which they are not entitled to belong.

The number of students, or the "bigness" of the college or university, is probably the most usual method of classification. But in regard to the number of students one finds a range continuous from institutions with fifty students to institutions with five thousand, and if in this continuous series arbitrary lines are drawn, the groups thus made put together institutions whose consideration side by side could serve no useful purpose; for instance, Johns Hopkins University with the University of Southern California, Yale University with the Temple College, and Williams College with Maryville College.

The size of the teaching staff would naturally be considered a more scientific method of classification, but here again there is a continuous gradation from institutions with five to institutions with five hundred teachers, and groups selected on this basis would result in such incongruities as placing Valparaiso University with Leland Stanford Junior University, Union College, Nebraska, with Amherst College, and Howard College at Birmingham, Alabama, with Ripon College.

The maintenance of professional schools might be considered as a significant line of cleavage, but such a means of demarcation, which would put in the supposedly less important group Princeton, Brown, Wesleyan, Vassar, Bryn Mawr, and Trinity (Hartford), and in the higher

group such institutions as Hamline University, Epworth University, Baylor University, Kansas City University, and some forty or fifty other essentially minor institutions can not be considered an illuminating classification.

The presence of a certain number of resident graduate students is a significant feature of an institution for higher education, and might be used with advantage in a classification if graduate students in the various institutions had to comply with similar requirements before being enrolled. It is true that the graduate student must have received a college degree, but a collegiate degree in the United States means anything from a bachelor of arts or a bachelor of science of such an institution as the Ohio Northern University, Ada, Ohio, up to the bachelor of arts and bachelor of science of such universities as Columbia, and the University of Chicago. Until the collegiate degrees begin to have a definite meaning, it will be futile to base any classification upon the graduate schools, which essentially rest upon these degrees.

The annual income is one of the better ways of grouping American colleges and universities, because a "dollar" is somewhat the same all over the United States; whereas a "student" may mean a person in the "school of oratory" or a candidate for the degree of doctor of philosophy. The word "teacher" may mean a full professor working exclusively for his college or a musician in Chicago who is the "nonresident director" of the schools of music of a chain of small colleges throughout Illinois and the adjacent states, the same individual being counted thus in a score or more of college catalogues. The test of annual income, however, fails to divide institutions into any sharp groups. The institutions range almost continuously from so-called colleges receiving an annual income of eight hundred and fifty dollars up to universities with a yearly budget of a million and a half dollars. It is true that between six hundred and fifty thousand dollars a year income and eight hundred and fifty thousand dollars a year income occurs a break, but there does not seem any solid reason why the ten universities above this break should be considered apart from the Universities of Missouri, Toronto, Pennsylvania, Minnesota and Nebraska, which come immediately below.

It must also be noted that the figures in regard to annual incomes are not absolutely to be relied upon. Many institutions say frankly that the return under this head is only an approximation, and although the foundation has made every effort to exclude such extraordinary items as gifts, special legislative appropriations for the erection of buildings, etc., from this calculation of annual incomes, it can not feel certain that in all cases the figures given under this head represent the normal yearly income of the institution—the income which can be devoted to running expenses. Thus the Ohio State University at Columbus, in estimating its annual income, included the unexpended balance of a legislative appropriation for building operations granted several years before, and Harvard University included in its annual income the value of certain securities which it had sold during the year in order to make a reinvestment. The foundation has been unable to obtain copies of all college treasurers' reports, and so has been unable to check all the returns made. Such inclusion of building appropriation, bookkeeping items, etc., will doubtless account for some cases where, according to the institution figures, a disproportionately small percentage of the income is devoted to the salaries of the instructing staff. In many small colleges, on the other hand, the regular income is

insufficient to pay the salary account, and it is necessary every year to make up the deficiency by the solicitations of gifts.

It may be mentioned here that the income of the University of Oregon, as given in the following table, is the income appropriated for it by the legislature a year and a half ago. The legislature of 1907 passed an act making an annual appropriation to the university of $125,000, but the referendum has been invoked against this act under the new initiative and referendum provision of the constitution of Oregon and the university, therefore, can not tell whether it will receive this appropriation until the referendum is held in June (1908). In the meantime, the university has to maintain itself upon the remnant of the old appropriation. This is the first time that the initiative and referendum has appeared in higher education in the United States.

Besides these reasons for not favoring the annual income as a means of classification, it should also be noted that in many institutions, particularly in women's colleges, the payments of the students for board are included in the income of the college. Wherever this is the case it is indicated in the table by a footnote. But while this footnote guards the reader from error, it does not enable the figures thus "starred" to be used for any useful purpose of calculation. To accept an income so calculated as if it were a real income would indicate that Vassar College was in receipt of a larger revenue than Princeton University, and the Randolph-Macon Woman's College than Radcliffe.

Since American colleges and universities fail under any system of classification to fall into natural groups, the only available method is to choose arbitrarily a system which is most useful for the purpose in view. A system of classification based on the amount of money expended annually for teachers' salaries has been adopted. This system results in incongruities. It places the College of the City of New York above the University of Virginia, and the Agricultural College of Utah above Clark University. But it results in fewer incongruous arrangements than any other single criterion.

There is one grave fault in this system of classification, and that is the impossibility of bringing within it the colleges and universities of the Roman Catholic Church. Almost all of these institutions are under the control of religious orders, and at least in the collegiate and graduate departments the teachers are priests who receive in money but a nominal compensation. The University of Notre Dame du Lac (Congregation of the Holy Cross) and Georgetown University (Society of Jesus), possessing incomes equal to those of Syracuse University and of Colgate University, must thus be omitted from this calculation, together with a number of less wealthy institutions whose revenues are on the scale of Rutgers and of De Pauw. But while the omission of these colleges and universities makes the list look incomplete, the omission is really unimportant in the economic sense. It would be meaningless to attempt a financial comparison between teachers to whom teaching is an ordinary economic function and teachers whose teaching is a part of their priestly duties. At some future time the foundation hopes to present from the pen of a distinguished ecclesiastic an adequate study of the Roman Catholic institutions.

The calculation on the basis of teachers' salaries will also be inadequate in regard to such institutions as New York University, where, as its syndic reports, a number of professors in all departments donate their services, in whole or in part, to the university. It will be necessary also to consider carefully the cases where

houses or apartments are added to the salaries of the members of the instructing staff. The houses at the University of Virginia and the suites of rooms at some of the colleges of the University of Toronto are a considerable addition to the stated salary, and even when, as at Washington and Lee University, a charge is made for the houses allotted to professors, the charge, in view of the character of the residence, is a nominal one.

Taking the salaries paid to teachers as a basis of classification of American and Canadian degree-giving institutions, we have the following table:

TABLE I

*Institutions Classified by Expenditure for Teachers' Salaries*

| Number of Institutions | Figures Indicating Range of Expenditure for Teachers' Salaries |
|---|---|
| 92 | $ 5,000–$10,000 |
| 91 | 10,000– 15,000 |
| 48 | 15,000– 20,000 |
| 29 | 20,000– 25,000 |
| 19 | 25,000– 30,000 |
| 18 | 30,000– 35,000 |
| 17 | 35,000– 40,000 |
| 17 | 40,000– 45,000 |
| 7 | 45,000– 50,000 |
| 6 | 50,000– 55,000 |
| 7 | 55,000– 60,000 |
| 8 | 60,000– 65,000 |
| 8 | 65,000– 70,000 |
| 4 | 70,000– 75,000 |
| 2 | 75,000– 80,000 |
| 4 | 80,000– 85,000 |
| 2 | 85,000– 90,000 |
| 1 | 90,000– 95,000 |
| 3 | 95,000–100,000 |
| 2 | 100,000–105,000 |
| 2 | 105,000–110,000 |
| 4 | 110,000–115,000 |
| 2 | 115,000–120,000 |
| 4 | 120,000–125,000 |
| 8 | 125,000–150,000 |
| 2 | 150,000–175,000 |
| 5 | 175,000–200,000 |
| 3[2] | 200,000–225,000 |
| 4[3] | 225,000–250,000 |
| 1[4] | 250,000–300,000 |
| 4[5] | 300,000–400,000 |
| 4[6] | 400,000–500,000 |
| 3[7] | 500,000–600,000 |
| University of Chicago | $ 699,000 |
| Harvard University | 841,000 |
| Columbia University | 1,145,000 |

[2] Johns Hopkins University, Northwestern University, New York University.

It will be seen from the table that five ninths of the institutions making reports have an instructional pay-roll of less than twenty thousand dollars. Failure to report this item is very common among the smaller institutions. Almost all the large institutions, on the other hand, send in this report. It is, therefore, safe to say that if the figures were obtainable in every case, two thirds of the degree-granting institutions of the United States and of Canada would show a budget for teachers' salaries of less than twenty thousand dollars. Seven ninths of the institutions making reports spend less than fifty thousand dollars on instructional salaries. If the list were complete, institutions of this character would number six sevenths of those granting degrees.

The average salary of a professor is reported in many more cases by the college authorities than is the college's total annual expenditure in professional and other instructing salaries. From a study of these figures it appears that one third of the degree-granting institutions pay on an average less than a thousand dollars a year to their full professors; indeed, in

[3] McGill University, University of Missouri, University of Nebraska, Ohio State University (Columbus).

[4] University of Minnesota.

[5] Massachusetts Institute of Technology, Princeton University, University of Toronto, Leland Stanford Junior University.

[6] University of California, University of Pennsylvania, University of Wisconsin, University of Illinois.

[7] Cornell University, Yale University, University of Michigan.

thirty-five institutions making reports the average salary of the full professor is less than five hundred dollars a year. These salaries are poor enough under any circumstances, but it must be remembered that most of the institutions paying such salaries are not colleges in any sense, except that they are called colleges and that they confer collegiate degrees. These poorly paid professors are therefore not really doing the work of higher education, nor have they in most cases given themselves adequate preparation for college teaching. In the vast majority of cases these professors are teaching high-school and even grammar-school subjects; they have devoted to their training only the time ordinarily given to preparation by a teacher in secondary education; and their salaries, although small, are not so utterly incommensurate as they would be if paid to a professor doing collegiate work.

To study the financial standing of the teachers in all of the degree-granting institutions would therefore be to deal with a large number of institutions that are simply high schools. Conclusions drawn from such a heterogeneous group would be of little value. Yet to draw a line across this ascending scale of college salary budgets is a difficult task. Wherever the line is drawn there will be reasons for moving it down to include a few more institutions or up to have it exclude a few others.

It will necessarily be an arbitrary line, but at one place in the gradation of institutions it will be less an arbitrary line than if drawn at any other place. A glance at Table I. shows that at the point where forty-five thousand dollars a year is spent on salaries to the instructing staff the number of institutions drops sharply. Above this abrupt drop are one hundred and three institutions. Let us, therefore, take these institutions as typical of American higher education, and see what are the results obtained from an analysis of the status of their professors and instructors. Table II. gives these one hundred and three institutions, with their appropriate figures, in the order of their annual expenditure in teachers' salaries.

It may be that there are colleges not included in Table II. which are better representatives of higher education than some which are there listed. The table does not pretend to give the one hundred institutions in America which are the best from an educational point of view, any more than the arrangement of institutions in the table is meant to indicate anything beyond the total size of the annual salary accounts. The value of this table is that it is an impersonal selection of colleges and universities according to a fairly representative criterion. For the purpose of this table, it is more valuable to have the selection made according to an objective standard which every one can estimate, than to have a more exact approximation into which personal judgment enters.

The foundation recognizes, however, that the salary budget of an institution is closely related to the size of the institution, and that the size of a college is an imperfect method of estimating its educational value. Table IX., in a later part of this paper, is therefore intended as a necessary supplement to Table II. It contains the names of fifty-four institutions, which were not included in Table II. on account of the comparative smallness of their expenditure for salaries, and yet which in the opinion of the foundation ought to be considered if the higher education of the United States is to be rightly estimated. Table IX. and the discussion thereon will show what excellent educational results can be obtained by resources which are within moderate limits.

These two tables, the one a purely ob-

jective selection on a mathematical basis, the other an attempt of the foundation to correct the false impression which a selection only on that standard might give, will together present an approximately complete statement of the financial status of the teacher in the institutions of higher education in the United States and Canada. Nevertheless the total number of institutions which assume to deal with the higher education can not be disregarded, although many of them are occupied in a large part with education that is not of a collegiate grade. While these colleges of meager support and limited facilities can not be grouped, as mentioned before, in significant educational divisions, it is evident to one who studies the countries as a whole that the problem of higher institutions must be taken up from the standpoint of the state or province as a unit. The state governments have themselves in all cases a system of education limited by state lines. The same denominations have erected colleges and universities in different states, so that the problem of higher education is almost necessarily studied from the standpoint of the state.

Looked at from this standpoint, it is evident that if the system of higher education is finally to have unity, strength, and thoroughness, enormous sums of money must be spent to develop these numerous institutions, or else many of them must be in the end abandoned. One can scarcely doubt that the latter course will finally come about by the mere progress of events, for there can be no doubt that many of these institutions are wholly unnecessary. They have been produced partly from a genuine interest in education; partly by denominational and local rivalry; sometimes by the enterprise of real estate agents; and under a system of laws which allowed any group of men to come together and call the institution which they founded a college. There are in most states many more such institutions than are necessary for the work of higher education and the multiplication of the number undoubtedly lowers the general standard of institutions.

Thus the State of Iowa contains six institutions of higher education in organic connection with the Methodist Episcopal Church.[8] Two of these, Cornell College and Upper Iowa University, are both under the control of the Upper Iowa Conference of that church. The combined revenues of these six institutions are only a little over one fifth of the sum appropriated each year by the people for the support of the state university. They about equal the annual revenue of Vanderbilt University. It is apparent that here has been a great dissipation of energy, when by a wise concentration of resources the Methodists of Iowa could have built up a single institution comparable with the excellent facilities of Vanderbilt, and able, if its organization had not been too widely extended, to have been an admirable colleague of the state university. The Presbyterian Church has also controlled four colleges in Iowa,[9] whose incomes, if combined, would have been equal to the incomes of Haverford or of Lafayette.

In Ohio the Methodist Episcopal Church has founded or given its official patronage to five separate institutions of learning.[10]

[8] Cornell College, Mount Vernon; Morningside College, Sioux City; Simpson College, Indianola; Upper Iowa University, Fayette; Iowa Wesleyan University, Mount Pleasant; and Charles City College, Charles City.

[9] Coe College, Cedar Rapids; Parsons College, Fairfield; Buena Vista College, Storm Lake; Lenox College, Hopkinton. Coe College, however, with the consent of the Synod of Iowa has recently taken into consideration an abrogation of this relationship to the Presbyterian Church.

[10] Ohio Wesleyan University, Delaware; Ohio Northern University, Ada; Mount Union College, Alliance; Scio College, Scio; and Baldwin University and the German Wallace College, Berea.

TABLE II

*Degree-conferring Institutions in the United States and Canada appropriating Annually $45,000 or over for the Total Payment of the Salaries of their Instructing Staffs*[11]

| Institution | Total Annual Income | Annual Appropriation for Salaries of Instructing Staff | Average Salary of Professor | Average Age at Entrance to Grade of Professor | Average Salary of Associate Professor | Average Salary of Assistant Professor | Total Number of Students in University | Total Instructing Staff in University | Ratio | Total Number of Students in Undergraduate Colleges and Nonprofessional Graduate Schools | Total Instructing Staff in Undergraduate Colleges and Nonprofessional Graduate Schools | Average Salary $2,048 Cost per Student $280 Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Columbia Univ. | $1,675,000 | $1,145,000 | $4,289 | 37.5 | | $2,201 | 4,087 | 559 | 7.3 | 2,545 | 253 | 10 |
| Harvard Univ. | 1,827,789 | 841,970 | 4,413 | 39 | $3,600 | 2,719 | 4,012 | 573 | 7 | 2,836 | 322 | 8.8 |
| [19]Univ. of Chicago. | 1,304,000 | 699,000 | 3,600 | | 2,800 | 2,200 | 5,070 | 291 | 17.4 | 3,902 | 211 | 18.4 |
| Univ. of Michigan. | 1,078,000 | 536,000 | 2,763 | | 2,009 | 1,624 | 4,282 | 285 | 15 | 2,899 | 198 | 14.6 |
| Yale Univ. | 1,088,921 | 524,577 | 3,500 | 35 | | 2,000 | 3,306 | 365 | 9 | 2,620 | 236 | 11.1 |
| [12]Cornell Univ. | 1,082,513 | 510,931 | 3,135 | | | 1,715 | 3,635 | 507 | 7.1 | 2,917 | 283 | 10.3 |
| Univ. of Illinois. | 1,200,000 | 491,675 | 2,851 | | 2,168 | 1,851 | 3,605 | 414 | 8.7 | 2,281 | 190 | 12 |
| Univ. of Wisconsin. | 998,634 | 489,810 | 2,772 | 32.8 | 2,081 | 1,636 | 3,116 | 297 | 10.4 | 2,558 | 231 | 11 |
| Univ. of Penna. | 589,226 | 433,311 | 3,500 | | | 1,850 | 3,700 | 375 | 9.8 | 2,618 | 166 | 15.7 |
| Univ. of California. | 844,000 | 408,000 | 3,300 | | 2,200 | 1,620 | 2,987 | 350 | 8.5 | 2,451 | 218 | 11.2 |
| Stanford Univ. | 850,000 | 365,000 | 4,000 | 35 | 2,700 | 2,000 | | | | [17]1,668 | 146 | 10.7 |
| Univ. of Toronto. | 610,000 | 324,000 | 3,600 | 42.5 | | 2,400 | 3,498 | 368 | 9.5 | 1,732 | 153 | 11.3 |
| [14]Princeton Univ. | 442,232 | 308,650 | 2,914 | 35 | | 1,824 | | | | 1,301 | 158 | 8.2 |
| Massachusetts Inst. | 505,000 | 301,000 | 3,192 | 38 | 2,115 | 1,653 | | | | 1,415 | 211 | 6.7 |
| Univ. of Minnesota. | 515,000 | 263,000 | 2,600 | 32 | | 1,700 | 3,889 | 303 | 12.8 | 2,169 | 116 | 18.6 |
| Ohio State Univ. | 475,000 | 244,000 | 2,041 | | 1,692 | 1,400 | 2,014 | 127 | 15.8 | 1,376 | 87 | 15.8 |
| Univ. of Nebraska. | 425,000 | 240,000 | 2,200 | 35 | | 1,500 | 2,886 | 173 | 16.6 | 1,808 | 90 | 20 |
| Univ. of Missouri. | 655,000 | 239,110 | 2,355 | 33 | | 1,575 | 2,070 | 144 | 14.3 | 1,360 | 101 | 13.4 |
| McGill Univ. | 425,000 | 225,000 | 3,060 | | 2,150 | 1,700 | 1,163 | 191 | 6 | 542 | 95 | 5.7 |
| New York Univ. | 303,500 | 220,000 | 3,466 | | | 1,830 | 3,110 | 211 | 14.7 | 827 | 46 | 17.9 |
| Northwestern Univ. | 491,132 | 218,157 | 3,265 | 35 | 2,325 | 1,535 | 2,485 | 261 | 9.5 | 936 | 56 | 16.7 |
| Johns Hopkins Univ. | 311,870 | 211,013 | 3,184 | | | 1,344 | 651 | 172 | 3.7 | 328 | 75 | 4.3 |
| Univ. of Texas. | 339,577 | 199,394 | 2,889 | 32.5 | 2,300 | 1,893 | 1,693 | 110 | 15.3 | 1,169 | 80 | 14.5 |
| Syracuse Univ. | 279,000 | 180,000 | 1,806 | | 1,291 | 978 | 2,875 | 199 | 14.4 | 1,807 | 89 | 20.3 |
| Smith College. | 278,717 | 177,150 | 2,150 | | | 1,646 | | | | 1,482 | 97 | 15.2 |
| Univ. of Kansas. | 285,000 | 176,000 | 2,100 | | 1,600 | 1,200 | 1,786 | 126 | 14.1 | 1,282 | 97 | 13.2 |
| N. Y. City College. | 455,000 | 175,270 | 4,788 | | 3,189 | 2,250 | | | | | | |
| State Univ. of Iowa. | 324,048 | 173,355 | 2,152 | 37.5 | | 1,271 | 1,791 | 149 | 12 | 1,200 | 86 | 13.9 |
| Dartmouth College. | 250,000 | 155,000 | 2,600 | 40 | 2,200 | 1,800 | 1,219 | 88 | 13.8 | 1,161 | 70 | 16.5 |
| Tulane Univ. | 274,000 | 146,000 | 3,000 | 35 | 2,000 | 1,500 | 1,433 | 148 | 9.6 | 525 | 55 | 9.5 |
| Iowa State College. | 210,000 | 140,286 | 2,000 | | 1,600 | 1,300 | | | | 1,098 | 108 | 10.1 |
| [14]Wellesley College. | 438,493 | 136,586 | 1,900 | | | 1,350 | | | | 1,209 | 118 | 10.2 |
| Vassar College | 483,000 | 129,500 | 2,896 | | | 1,690 | | | | 996 | 81 | 12.2 |
| Kansas State College. | 393,500 | 129,100 | 2,140 | 34.5 | | 1,435 | | | | 1,034 | 69 | 14.9 |
| Indiana Univ. | 215,000 | 129,000 | 2,400 | 35 | 1,707 | 1,200 | | | | | | |
| Purdue Univ. | 255,000 | 128,920 | 2,200 | | | 1,800 | 1,713 | 124 | 13.8 | 1,605 | 119 | 13.4 |
| Oberlin College | 223,729 | 128,400 | 1,941 | 33 | | 1,250 | 1,406 | 109 | 12.8 | 803 | 44 | 18.2 |
| Univ. of Cincinnati. | 254,699 | 123,141 | 3,000 | 35 | 2,000 | 1,300 | 994 | 120 | 8.2 | 638 | 52 | 12.2 |
| Armour Institute. | 215,000 | 123,000 | 2,150 | 35 | 1,682 | 1,328 | | | | 622 | 62 | 10 |
| Univ. of Virginia. | 202,190 | 122,960 | 3,100 | 35 | | 1,425 | 785 | 91 | 8.6 | 467 | 61 | 7.6 |
| Univ. of Washington. | 202,000 | 122,400 | 1,950 | | 1,700 | 1,450 | 1,061 | 72 | 14.7 | 907 | 64 | 14.1 |
| Westrn. Reserve Univ. | 179,661 | 116,141 | 2,700 | | 1,880 | 1,790 | 914 | 155 | 5.8 | 566 | 53 | 10.6 |
| Agric. Col. of Utah. | 130,566 | 115,400 | 1,800 | 35 | | 1,300 | | | | 530 | 55 | 9.6 |
| [15]Brown Univ. | 214,198 | 114,630 | 2,680 | 37 | 1,843 | 4,389 | | | | 924 | 81 | 11.4 |
| Washington Univ. | 158,051 | 114,034 | 2,471 | | | 1,400 | 1,124 | 174 | 6.4 | 331 | 45 | 7.3 |
| West Virginia Univ. | 200,000 | 110,000 | 2,080 | 35 | 1,600 | 1,350 | 667 | 62 | 10.7 | 284 | 41 | 6.9 |
| Michigan State Col. | 325,000 | 110,000 | 2,300 | 34 | 2,000 | 1,200 | | | | 683 | 78 | 8.7 |
| Lehigh Univ. | 166,500 | 107,000 | 2,137 | 30 | | 1,537 | | | | 674 | 75 | 11.8 |

TABLE II—*continued*

*Degree-conferring Institutions in the United States and Canada Appropriating Annually $45,000 or over for the Total Payment of the Salaries of their Instructing Staffs* [11]

| Institution | Total Annual Income | Annual Appropriation for Salaries of Instructing Staff | Average Salary of Professor | Average Age at Entrance to Grade of Professor | Average Salary of Associate Professor | Average Salary of Assistant Professor | Total Number of Students in University | Total Instructing Staff in University | Ratio | Total Number of Students in Undergraduate Colleges and Nonprofessional Graduate Schools | Total Instructing Staff in Undergraduate Colleges and Nonprofessional Graduate Schools | Average Salary $2,048. Cost per Student $280. Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bryn Mawr College... | $126,808 | $106,687 | $2,500 | | $2,000 | $1,500 | | | | 362 | 47 | 7.7 |
| Tufts College..... | 180,000 | 104,600 | 1,870 | | | 1,375 | 1,083 | 198 | 5.4 | 453 | 45 | 10 |
| George Wash. Univ... | 189,643 | 101,610 | 1,693 | 32.5 | | 1,094 | 1,258 | 196 | 6.4 | 643 | 82 | 7.8 |
| Penna. State College.. | 251,920 | 97,190 | 2,010 | | | 1,390 | | | | 784 | 81 | 9.6 |
| Univ. of Colorado..... | 175,000 | 95,000 | 2,050 | 32 | | 1,400 | 840 | 112 | 7.5 | 726 | 57 | 12.7 |
| Williams College..... | 168,000 | 95,000 | 2,714 | 32 | 2,100 | 1,730 | | | | 475 | 58 | 8.1 |
| Clemson Agric. Col... | 271,720 | 93,650 | 2,100 | | 1,800 | 1,400 | | | | 658 | 41 | 16 |
| Univ. of Utah..... | 156,000 | 85,653 | 1,881 | | 1,900 | 1,700 | 565 | 50 | 11.3 | 390 | 39 | 10 |
| Amherst College..... | 133,214 | 85,500 | 2,853 | 36 | 1,700 | 1,566 | | | | 513 | 38 | 13.5 |
| Vanderbilt Univ..... | 169,000 | 83,000 | 2,800 | | 1,900 | 1,400 | 902 | 110 | 8.1 | 342 | 44 | 7.7 |
| Boston Univ..... | 186,484 | 82,340 | 2,419 | 35 | | 1,628 | 1,428 | 150 | 9.5 | 519 | 34 | 15.2 |
| [14]Mount Holyoke Col. | 225,000 | 81,000 | 1,350 | 40 | | 1,100 | | | | 711 | 87 | 8.1 |
| State Col. of Wash.... | 130,000 | 80,000 | 1,750 | 35 | 1,700 | 1,400 | | | | 1,100 | 65 | 16.9 |
| [12]Univ. of Tennessee.. | 153,877 | 78,000 | 2,000 | 39 | 1,600 | 1,300 | 694 | 106 | 6.5 | 353 | 34 | 10.3 |
| Western Univ. of Pa.. | 137,139 | 76,617 | 1,864 | 38 | | | 966 | 144 | 6.7 | 187 | 23 | 8.1 |
| Texas College.. ..... | 160,000 | 74,000 | 2,000 | | | 1,300 | | | | 623 | 52 | 11.9 |
| Univ. of North Car... | 104,121 | 72,326 | 1,975 | | | 1,242 | 731 | 73 | 10 | 483 | 48 | 10 |
| State Univ. Oklahoma | 110,000 | 72,274 | 1,800 | | | 1,400 | 394 | 36 | 10.9 | 201 | 28 | 7.1 |
| Clark Univ ..... | 145,000 | 70,000 | 3,000 | | | 1,650 | | | | 159 | 37 | 4.2 |
| Stevens Inst. of Tech. | 108,000 | 69,000 | 3,200 | | | 2,000 | | | | 429 | 42 | 10.2 |
| Univ. of Maine..... | 135,000 | 69,357 | 1,800 | 34 | 1,500 | 1,200 | 702 | 74 | 9.4 | 514 | 50 | 10.2 |
| Drake Univ..... | 101,856 | 67,849 | 1,500 | 32 | | 1,000 | 866 | 93 | 9.3 | 515 | 20 | 25.7 |
| Miami Univ..... | 113,000 | 66,300 | 2,000 | | 1,650 | 1,150 | 570 | 41 | 13.9 | 313 | 28 | 11.1 |
| Ohio Wesleyan Univ. | 165,000 | 66,000 | 1,800 | | 1,300 | 850 | 1,178 | 119 | 9.8 | 580 | 43 | 13.4 |
| Univ. North Dakota.. | 153,136 | 65,500 | 2,200 | 35 | | 1,550 | 425 | 49 | 8.6 | 230 | 30 | 7.6 |
| Wesleyan Univ..... | 123,000 | 65,000 | 2,575 | 33 | | 1,750 | | | | 316 | 29 | 10.8 |
| Alabama Polyt. Inst.. | 92,000 | 65,000 | 2,000 | | 1,700 | 1,500 | | | | 543 | 50 | 10.8 |
| Worcester Polyt. Inst.. | 89,594 | 61,107 | 2,369 | | | 1,725 | | | | 465 | 46 | 10.1 |
| Simmons College..... | 127,024 | 61,000 | 2,900 | | 2,266 | 1,660 | | | | 545 | 59 | 9.2 |
| Colgate Univ..... | 114,532 | 60,930 | 1,740 | | | 1,500 | | | | 287 | 24 | 11.9 |
| Va. Polytechnic Inst. | 118,000 | 60,764 | 1,980 | 33 | | 1,260 | | | | 577 | 57 | 10.1 |
| Case Sch. Applied Sci. | 145,500 | 60,205 | 2,861 | 32.5 | | 1,443 | | | | 440 | 40 | 11 |
| Ohio Univ..... | 165,000 | 60,160 | 1,900 | 25 | 1,600 | 900 | 1,224 | 38 | 32.2 | 414 | 21 | 19.7 |
| Union Univ..... | 110,126 | 60,159 | 2,300 | 35 | | 1,400 | 627 | 108 | 5.7 | 270 | 33 | 8.1 |
| Univ. of Vermont..... | 105,000 | 60,000 | 2,100 | 35 | 1,650 | 1,375 | 497 | 65 | 7.6 | 345 | 37 | 9.3 |
| Rensselaer Poly. Inst. | 110,400 | 58,721 | 3,300 | 35 | 2,500 | 1,800 | | | | 485 | 29 | 16.8 |
| Howard Univ..... | 91,555 | 58,619 | 1,837 | 32.5 | | 1,000 | 785 | 92 | 8.5 | 265 | 17 | 10.1 |
| Queen's University... | 88,221 | 58,351 | 2,000 | | | 1,200 | 1,134 | 80 | 14.1 | 914 | 48 | 19 |
| Univ. of Mississippi... | 105,000 | 57,300 | 2,000 | | 1,325 | 1,000 | 344 | 28 | 12.2 | 274 | 24 | 11.4 |
| Univ. of S. Dakota... | 80,000 | 56,000 | 1,650 | | | 1,100 | 359 | 44 | 8.1 | 173 | 18 | 9.6 |
| Swarthmore College.. | 84,000 | 55,335 | 2,100 | | | 1,400 | | | | 332 | 36 | 9.2 |
| Ga. Sch. Technology. | 82,500 | 55,000 | 1,945 | | | 1,000 | | | | 562 | 42 | 13.3 |
| Univ. of Idaho..... | 99,639 | 54,920 | 1,800 | | | 1,581 | | | | 231 | 28 | 8.2 |
| Temple College..... | 72,895 | 54,272 | 1,500 | 35 | | | 2,343 | 198 | 11.8 | 199 | 31 | 6.4 |
| Radcliffe College..... | 90,000 | 53,000 | [16] | | | | | | | | | |
| Rutgers College..... | 87,000 | 53,000 | 2,300 | | | 1,600 | | | | 255 | 34 | 7.5 |
| North Dakota College | 114,000 | 52,150 | 2,000 | 30 | | 1,300 | | | | 820 | 33 | 24.8 |

TABLE II—*continued*

*Degree-conferring Institutions in the United States and Canada appropriating Annually $45,000 or over for the Total Payment of the Salaries of their Instructing Staffs* [11]

| Institution | Total Annual Income | Annual Appropriation for Salaries of Instructing Staff | Average Salary of Professors | Average Age at Entrance to Grade of Professor | Average Salary of Associate Professor | Average Salary of Assistant Professor | Total Number of Students in University | Total Instructing Staff in University | Ratio | Total Number of Students in Undergraduate Colleges and Nonprofessional Graduate Schools | Total Instructing Staff in Undergraduate Colleges and Nonprofessional Graduate Schools | Average Salary $2,048 Cost per Student $280 Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wash. and Lee Univ. | $70,000 | $50,000 | $2,600 | 35 | | $1,500 | 468 | 35 | 13.3 | 385 | 32 | 12 |
| State Univ. of Ky..... | 90,247 | 49,250 | 2,000 | 33 | | 1,200 | | | | 466 | 43 | 10.8 |
| James Millikin Univ. | 64,003 | 49,160 | 1,400 | 30 | | 1,000 | | | | 231 | 32 | 7.2 |
| N. Carolina College... | 114,000 | 49,000 | 2,000 | 30 | | 1,240 | | | | | | |
| Montana State College | 133,000 | 48,650 | 1,800 | | | 1,500 | | | | 291 | 32 | 9 |
| Univ. of Oregon..... | 60,000 | 47,927 | 1,800 | 40 | | 1,400 | 570 | 87 | 6.5 | 340 | 34 | 10 |
| Haverford College..... | 78,650 | 45,300 | 3,440 | 35 | | 2,240 | | | | 143 | 22 | 6.5 |
| Univ. of Rochester... | 60,334 | 45,000 | 2,383 | | | 1,750 | | | | 340 | 21 | 16.1 |

[11] The data for instructors and assistants are omitted.

[12] Not including Medical School.

[13] Including the preceptors as assistant professors.

[14] Including payments of students for board.

[15] Most of the faculty receive a small extra compensation for teaching at the Women's College.

[16] Faculty consists of members of the faculty of Harvard University, paid a certain amount per course.

[17] Law students are not classified separately from collegiate undergraduates.

[18] A combination of the average salary of associates, $1,469, and the average salary of instructors, $1,050.

[19] Professors who are heads of departments receive on an average $5,800.

The Presbyterian Synod of Tennessee (north) elects the trustees of Maryville College, and also the trustees of Greenville and Tusculum Colleges. Washington College, while its trustees are not elected by the synod, is a Presbyterian institution. All three of these colleges are located in the mountainous region of East Tennessee. The Northern Presbyterian Church, through its recent union with the Cumberland Presbyterian Church, has also come into possession of Cumberland University in Central Tennessee. The Southern Presbyterian Church has a university in West Tennessee. If all of these institutions are really devoted to higher education, it is evident that one or more of them are superfluous. Throughout the country there are numerous instances of single bodies in one denomination, like the Northern Presbyterian Synod of Tennessee, having within their own limited area more than one college or university. There is something pathetic in the devotion which is poured into some of these unnecessary colleges. One finds an institution in which the few college students who come are instructed by perhaps a single competent teacher, assisted by professors who are young boys just out of college. The salaries are pitifully small, the "dean" in such a college sometimes receiving not more than $800 a year and the professors $50 a month. The small endowment which has been given suffices to keep the institution alive and there is often poured into it a large measure of sincere but misguided devotion, the more to be regretted because the students who come to such an institution can usually

TABLE IX

*Data concerning Partial List of Institutions in which Annual Expenditure for Instructing Salaries Ranges from $10,000 to $45,000*

| Institution | Total Annual Income | Annual Appropriation for Salaries of Instructing Staff | Average Salary of Professor | Average Age of Entrance to Grade of Professor | Average Salary of Associate Professor | Average Salary of Assistant Professor | Total Number of Students in Institution | Total Instructing Staff in Institution | Ratio | Total Number of Students in College | Total Instructing Staff in College | Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Iowa College | $60,000 | $44,250 | $1,500 | 33 | $1,000 | $ 950 | [21]553 | 35 | 15.8 | 450 | 31 | 14.5 |
| Polytech. Inst., Brooklyn. | 59,000 | 43,150 | 2,783 | | | 1,234 | | | | 250 | 40 | 6.2 |
| University of the South | 60,845 | 42,836 | 1,500 | 35 | | 1,100 | [21]317 | 34 | 9.3 | 119 | 11 | 10.8 |
| DePauw University | 67,000 | 42,750 | 2,000 | | | 850 | [21]753 | 35 | 21.5 | 548 | 25 | 21.9 |
| Pomona College | 50,000 | 42,000 | 1,500 | | | [22]1,050 | [21]317 | 31 | 10.2 | 267 | 23 | 11.6 |
| Lafayette College | 77,142 | 40,374 | 2,000 | | | 1,370 | | | | 442 | 36 | 12.2 |
| Bowdoin College | 72,063 | 39,550 | 2,000 | 30 | | 1,350 | 394 | 53 | 7.4 | 305 | 20 | 15.2 |
| University of Wyoming | 84,299 | 39,080 | 1,900 | 34 | 1,700 | 1,500 | [21]222 | 30 | 7.4 | 110 | 21 | 5.2 |
| Colorado College | [20]60,000 | 38,000 | 1,775 | | | 1,056 | [21]607 | 44 | 13.7 | 407 | 31 | 13.1 |
| Dickinson College | 61,748 | 37,576 | 1,700 | 33 | | [22]1,200 | 392 | 26 | 15 | 314 | 18 | 17.4 |
| Adelphi College | 54,000 | 37,575 | 2,000 | | | 1,400 | [21]463 | 27 | 17.1 | 295 | 24 | 12.2 |
| University of Arizona | 90,000 | 37,300 | 1,900 | | | 1,200 | | | | [21]63 | [23]7 | 9 |
| Univ. of South Carolina | 72,857 | 36,730 | 2,000 | | 1,500 | 1,200 | [21]285 | 29 | 9.8 | 191 | 18 | 10.6 |
| Cornell College | 55,436 | 36,702 | 1,220 | 32 | | [22]900 | [21]455 | 39 | 11.6 | 395 | 27 | 14.6 |
| Woman's Col., Baltimore. | 67,151 | 36,450 | 1,818 | 32.5 | | [22]1,167 | | | | 340 | 28 | 12.1 |
| Trinity College, Conn. | 43,045 | 36,250 | 2,000 | | | 1,400 | | | | 208 | 22 | 9.4 |
| Beloit College | 75,000 | 35,000 | 1,600 | 32 | | 1,200 | | | | 303 | 30 | 10.1 |
| Wash. and Jeff. College | 46,880 | 34,500 | 1,823 | | | | | | | 264 | 16 | 16.5 |
| Allegheny College | 47,000 | 34,200 | 1,800 | 34 | | 1,200 | | | | 266 | 19 | 14 |
| Lawrence University. | 43,000 | 34,000 | 1,400 | 31 | | 950 | [21]493 | 33 | 14.9 | 327 | 26 | 12.5 |
| Dalhousie University | 40,240 | 33,500 | 2,300 | | | [22]1,500 | 358 | 48 | 7.4 | 266 | 21 | 12.6 |
| Trinity College, N. C. | 63,000 | 33,060 | 1,850 | | | 750 | [21]280 | 26 | 10.7 | 264 | 23 | 11.4 |
| Lake Forest College | 41,165 | 32,932 | 1,800 | 33 | | 1,300 | [22][26]358 | | | [21]217 | 19 | 11.4 |
| Rand.-Mac. Woman's Col. | [24]130,713 | 32,707 | 1,639 | 37.5 | | [25]1,307 | | | | | | |
| Hamilton College | 50,000 | 32,500 | 1,800 | | | 1,300 | | | | 178 | 19 | 9.3 |
| Rose Polytechnic Institute | 43,756 | 31,600 | 2,250 | 37.5 | 1,800 | 1,200 | | | | 229 | 23 | 9.9 |
| Colorado School of Mines. | 110,000 | 30,500 | 2,233 | | | 1,550 | | | | [22]294 | 17 | 17.2 |
| University of Wooster | 43,057 | 31,380 | 1,500 | 37.5 | | [21]1,100 | 547 | 34 | 16 | 362 | 28 | 12.9 |
| University of Montana | 71,500 | 30,100 | 1,800 | | | | [22]247 | 20 | 12.3 | 189 | 19 | 9.9 |
| Olivet College | 46,600 | 29,200 | 1,300 | 35 | | 1,000 | [22]255 | 29 | 8.7 | 211 | 20 | 10.5 |
| Albion College | 37,078 | 28,775 | 1,550 | 30 | | 900 | [22]383 | 25 | 16.1 | 239 | 17 | 14 |
| Kenyon College | [27]47,000 | [27]28,500 | 1,600 | 32.5 | | | | | | 118 | 15 | 7.8 |
| College of Wm. and Mary | 43,000 | 28,495 | 1,800 | | | [21]1,000 | | | | | | |
| Mt. St. Mary's College | 50,000 | 28,000 | [28]1,000 | | | [28]400 | | | | | | |
| Bates College | 39,167 | 26,500 | 1,433 | 32 | | | | | | 438 | 23 | 19 |
| Wilson College | [24]110,000 | 26,500 | [28]1,000 | 32 | | [28]900 | [22]344 | 34 | 10.1 | 240 | 22 | 10.9 |
| Earlham College | 58,000 | 24,000 | 1,550 | 30 | | | [22]380 | 31 | 12.2 | 325 | 27 | 12 |
| Wabash College | 41,608 | 23,550 | 1,600 | | | 930 | | | | [22]291 | 17 | 17.1 |
| Carleton College | 34,900 | 23,150 | 1,400 | 32 | | [21]1,300 | [22]315 | 20 | 15.7 | 281 | 17 | 16.5 |
| Colby College | 56,939 | 23,033 | 1,800 | 32.5 | | [21]1,350 | | | | [22]237 | 15 | 15.8 |
| Marietta College | 24,244 | 22,670 | 1,433 | | | [21]1,120 | 275 | 21 | 13 | 129 | 16 | 8 |
| Centre College | 32,369 | 21,827 | 1,600 | 30 | | | | | | [22]154 | 20 | 7.7 |
| Hobart College | 37,200 | 21,657 | 1,700 | 35 | 1,400 | 1,100 | | | | 104 | 16 | 6.5 |
| Wells College | [24]90,041 | 21,150 | 1,600 | 36.5 | 1,275 | 900 | | | | 169 | 24 | 7 |
| Drury College | 29,000 | 21,000 | 1,400 | | | 687 | [22]461 | 21 | 21.9 | 269 | 14 | 19.2 |
| Coe College | 28,137 | 20,989 | 1,200 | 30 | | 700 | | | | [22]206 | 28 | 7.3 |
| Ripon College | 47,100 | 20,900 | 1,336 | | | 800 | [22]201 | 24 | 8.3 | 157 | 20 | 7.8 |

TABLE IX—*continued*

*Data concerning Partial List of Institutions in which Annual Expenditure for Instructing Salaries Ranges from $10,000 to $45,000*

| Institution | Total Annual Income | Annual Appropriation for Salaries of Instructing Staff | Average Salary of Professor | Average Age of Entrance to Grade of Professor | Average Salary of Associate Professor | Average Salary of Assistant Professor | Total Number of Students in Institution | Total Instructing Staff in Institution | Ratio | Total Number of Students in College | Total Instructing Staff in College | Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Middlebury College..... | $28,491 | $20,160 | $1,870 | 32 | | | | | | [22]178 | 11 | 16.1 |
| Penna. Col. for Women... | 41,000 | 20,000 | [28]900 | 28 | | | | | | 45 | 10 | 4.5 |
| Elmira College..... | 38,139 | 18,672 | [28]1,000 | 30 | | | 278 | 17 | 16.3 | 197 | 12 | 16.4 |
| Monmouth College..... | 36,967 | 18,500 | 1,270 | 35 | | $1,075 | [22]425 | 25 | 17 | 233 | 18 | 12.9 |
| Franklin College ..... | 37,552 | 15,000 | 1,350 | 28 | | | [22]214 | 15 | 14.2 | 160 | 13 | 12.3 |
| Clarkson Me. Sch. of Tech. | 24,540 | 11,950 | 1,350 | | | | | | | [22]80 | 11 | 7.2 |
| Knox College..... | 28,012 | 11,509 | 1,400 | 32 | | 1,200 | [22]521 | 27 | 19.2 | 224 | 19 | 11.7 |

[20] Interest at 5 per cent. on $500,000 additional endowment will be available in 1909.

[21] Entitled "associate professors."

[22] Catalogue for 1906–7.

[23] Exclusively in college.

[24] Including payments of students for board.

[25] Entitled "adjunct professors."

[26] Catalogue does not separate the students in the department of music, of art and of physical culture from the students in the college.

[27] Including Bexley Hall, the theological seminary.

[28] Also board, apartments and laundry.

find much better instruction in near-by colleges, or high schools, where the teaching staff is stronger, the facilities better, and the temptations to low standards are not present. In some parts of the union, colleges which are only high schools are fulfilling a most useful educational function. It might well be considered by these latter colleges, however, whether it would not be better for education in general, and more dignified on their part, for them to discontinue granting the college degrees, and frankly call themselves high schools or academies or junior colleges.

At an early date the foundation hopes to present a thorough study of the institutions of higher learning in several states from the point of view of the area, population, material resources and probable expansion of each state. There are states whose territory is so great or which are so divided by natural barriers that duplicate institutions may be justified, just as there are states whose citizens are justified in thinking more in terms of the future than of the present. All these things should be taken into account in estimating the field of higher education within a single state.

Occasionally in this paper figures will be given and comparisons made which might be considered to imply criticism of the internal administration of institutions. It must be remembered in this connection that there has been but little study in comparative college economics. It would seem that colleges and universities have managed their finances and drawn up their budgets with slight knowledge of similar problems in other colleges and universities. Data on this subject were not easily

obtainable. But from the data collected it is evident that widely differing systems of administration prevail.

Table II. does not contain the names of all the colleges and universities in the United States and Canada which pay $45,000 or over in salaries annually to their instructing staffs, because some such institutions did not answer inquiries of the foundation, or return answers in a form available for statistical purposes. The table contains the names of one hundred and three colleges and universities in the United States and Canada which have given specific information that their total payments in instructing salaries exceed $45,000 annually.[10a]

## *THE TEACHING OF MATHEMATICS TO ENGINEERING STUDENTS IN FOREIGN COUNTRIES*[1]

YOUR committee has asked me to speak of the teaching of mathematics in foreign engineering colleges. My remarks will have reference almost exclusively to the German colleges and schools, partly because I am most familiar with the conditions existing in Germany and partly on account of the rather instructive campaign for reforming the whole teaching of mathematics, recently inaugurated in Germany.

As regards other countries I will only say that the situation in England and Scotland where, during the last quarter of a century, technical education has rapidly developed on quite characteristic and individual lines, deserves careful attention. But I am not sufficiently well acquainted with the facts to discuss this educational movement. In France, it is well known that the theoretical training given to engineers is on a very high level, higher even than in Germany, I believe. Thus, the requirements for admission to the École Polytechnique, or even to the École Centrale, include in mathematics almost as much as our engineering students get in their college course. On the top of this preparation, the student receives in the École Polytechnique an excellent two years' course in higher analysis and theoretical mechanics, and then only is he allowed to enter upon his special technical work. It must also be taken into account that admission to the École Polytechnique is by competitive examinations held throughout France, so that this institution, receiving as it does the pick of students from the whole country, can maintain a high level of theoretical excellency. The École des Ponts et Chaussées and the École des Mines to which the student passes from the École Polytechnique, are thus what we might call graduate schools of the highest rank.

Turning now to the German engineering colleges, a comparison with our own best engineering colleges shows apparently but little difference, both as regards requirements for admission and as to the schedule of courses offered in the schools themselves. Nevertheless, I believe that the scientific standard is decidedly higher in the German than in the American engineering college. I am not here concerned with the question whether such a high standard of theoretical knowledge is essential, or even desirable, for the engineer; I merely state the fact. Moreover, it is quite possible that ultimately the average German engineer knows no more mathematics than the average American engineer. All I wish to maintain is that, in my opinion, an able German student, in his Technische Hochschule, or engineering university, can gain a more thorough scientific equipment than an equally able American student in his alma mater.

[10a] The data for instructors and assistants are not reproduced.—ED.

[1] Read before Sections A and D, American Association for the Advancement of Science, and the Chicago Section of the American Mathematical Society, Chicago meeting, December 30, 1907.

The mathematical requirements for admission are about the same in Germany as with us: algebra, geometry, trigonometry. Not a few students now enter the German engineering college with some knowledge of analytic geometry and even of calculus, but many still come without this knowledge. The important point is that the preparatory training in mathematics (including arithmetic) is distributed systematically and continuously over a period of nine years. The same is true of other preparatory studies. It is obviously quite impossible to attain in a four-year high-school course the results attained in the nine-year course of a German Gymnasium, Realgymnasium, or Oberrealschule. This difference in preparation must always be kept in mind in making comparisons between German and American universities.

The mathematical courses offered in the German engineering colleges and required for a degree cover plane and solid analytic geometry, differential and integral calculus and differential equations—*i. e.*, about the same subjects that are required in this country. The subject of theoretical mechanics, which is treated rather differently in different schools, and even in the same school for different degrees, I shall here leave out of consideration, for the sake of simplicity. The amount of time devoted to the higher mathematics, not including mechanics, appears roughly from the following table, in which the first figure in each case gives the number of hours per week devoted to lectures, the second the number of hours devoted to "exercises." These exercises are a comparatively recent innovation. In my time the student had nothing but lectures; to gain a working knowledge of the subject he had to take a text-book and work for himself. Even now, these exercises are optional; they probably exist everywhere, although the table may not show them. There are no periodic examinations such as we have at the end of each semester; but most students take at the end of their course the Staatsexamen, or if particularly ambitious, the Diplomexamen. The lectures in mathematics are rather more advanced and more complete than those in our engineering colleges. But the requirements in the final examinations are not very high.

| | First Semester | Second Semester | Third Semester | Fourth Semester | Total |
|---|---|---|---|---|---|
| Karlsruhe..... | 6+2 | 6+2 | 3 | 2 | 17+4 |
| Stuttgart..... | 7+3 | 6+4 | 3+1 | ..... | 16+8 |
| Munich..... | 6+3 | 6+2 | 5+2 | 2+2 | 19+9 |
| Hannover..... | 8+1 | 6+2 | ..... | ..... | 14+3 |
| Danzig..... | 6 | 5 | 4+1 | 3+1 | 18+2 |
| Braunschweig ... | 8+2 | 6+2 | 2 | ..... | 16+4 |
| Zürich ..... | 8+4 | 8+4 | 4+1 | ..... | 20+9 |

In addition to the more thorough preparation of the German student and to the somewhat higher standard of the lectures on pure mathematics, and largely owing to these circumstances, the treatment of applied mathematics is, I believe, on a higher level in Germany than in this country. The student is better prepared; no time is lost in "recitations," *i. e.*, in trying to find out whether the student has committed things to memory; the professor is thus enabled to treat scientific questions scientifically. Besides, on an average, the German professor of an engineering subject has himself a higher degree of scientific training and is more interested in the mathematical, and in general the scientific, aspects of his subject than his American colleague.

It is of course always hazardous and, moreover, of little use to make such general statements and comparisons; and I do not wish to attach any great importance to them. Neither the German nor the American engineering college is as good as it might be or should be; no institution ever is; an institution is good only in so

far as it is continually changing, developing, rising. The above comparisons are, therefore, given merely as a basis for better understanding the efforts that are now made in Germany for the improvement of mathematical teaching in all its phases. To these efforts I wish to call your special attention.

The German movement for the reform of the teaching of mathematics is of a somewhat complex nature; at least three different movements may be distinguished. One of these, originating with the German association of engineers (Verein deutscher Ingenieure) had as its direct object the improvement of the mathematical instruction in the engineering colleges, with a view to making the instruction less abstract and theoretical and more practically useful to the engineer. To a certain extent, this object has been attained. Practical exercises for acquiring a working knowledge of mathematics have been introduced everywhere, and the lectures on pure mathematics have become less theoretical. Some of the originators of this movement, especially Professor Riedler, of the Charlottenburg College, went so far as to demand that in engineering colleges mathematics should be taught by engineers. Whether or not this was meant as more than a threat I do not undertake to say; certainly, as far as my knowledge goes, no attempt has ever been made in a German engineering college to put the teaching of mathematics in the hands of any one but a trained mathematician. But I believe that in the selection of men for such positions more attention has been paid in recent years to the qualifications of the aspirants; mathematicians with a bent towards applied science being given the preference for positions in engineering colleges.

The second of the three movements referred to above has for its object the reform of the teaching of mathematics in the universities. It is the oldest of these movements, and has borne fruit in a variety of ways. But I can here only advert to it very briefly. The tremendous creative mathematical activity that characterized the last three quarters of the nineteenth century in Germany led to a condition in the universities that was injurious to the preparation of teachers for the secondary schools (Gymnasium, Realgymnasium, Oberrealschule). Too much stress was laid on leading the student as fast as possible to original research in some special line. The system has been described as a system, not of double entry, but of double forgetting; upon entering the university the students, most of whom are fitting for teaching in the secondary schools, are made to forget and almost despise the more elementary mathematics, and when beginning their professional teaching career they are again compelled to forget as fast as possible all the higher and highest mathematics to which they had devoted most of their time at the university. The remarkable development of mathematical activity in our country during the last fifteen or twenty years may bring about a similar situation. Fortunately, the leaders of American mathematics are well aware of the danger of losing the healthy contact with the more elementary mathematics and with applied science. Of course, it is, and always will be, the chief object of a real university to foster original research and productive scholarship. But it is well even for the most advanced specialist not to burn the bridges behind him, but to keep in mind the connection of his specialty with the foundations of knowledge, on the one hand, and with kindred branches of science on the other. As Sir Isaac Newton expressed it in his quaint way in a letter to Dr. Lord: "He that in ye mine of knowledge deepest diggeth, hath, like every other miner, ye

least breathing time, and must sometimes at least come to terr, alt for air."

The desire to make the university teaching of mathematics more practically useful and bring it into live contact, as far as possible, with the whole tendency of modern scientific thought led, on the one hand, to a strengthening of all branches of applied mathematics, not only by courses offered in the universities, but also by such publications as the Encyklopädie, which includes applied mathematics in the widest application of the term; on the other, it led to reforms in the courses offered to future teachers of mathematics, and ultimately to a thorough investigation of the teaching of elementary mathematics in the secondary schools of Germany.

The improvement of the teaching of elementary mathematics is the aim of the third and most recent mathematical reform movement in Germany. The reforms proposed in this connection by the committee of the German Association of Naturforscher und Aerzte, at the Meran meeting, in 1905, appear to me to deserve very careful consideration. They would apply, in this country, to the teaching of mathematics not only in the high schools, but just as much in the engineering colleges. For, with the preparation that our students actually have, I am convinced that the best method of imparting a good working knowledge of the elements of analytic geometry and calculus is not through lectures, but through actual teaching based mainly on solving problems, that is, by the methods not of the German university, but of the German secondary school.

The proposals of the committee[2] do not change very essentially the number of hours required for mathematics. These are to be: in the Gymnasium as well as in the Realgymnasium, four hours per week in each of the nine years; in the Oberrealschule generally four hours per week, in the third and fourth years six hours. The first three years are devoted to common arithmetic and intuitional geometry, the next three years to algebra and geometry carried along together, the last three years to advanced algebra, trigonometry, advanced geometry, conic sections (treated synthetically and analytically) and, in the Oberrealschule, the elements of the calculus. Apart from matters of detail this distribution does not vary very much from the practise now followed in the best Prussian schools.

While thus the general program can not be said to constitute a radical departure from existing conditions, the statement of what should be the principal aim of mathematical teaching and the indications given for carrying out this aim throughout the whole course[3] appear to me as the most important features of the report. In addition to the well-recognized object of mathematical teaching to train the mind in rigorous logical reasoning the report insists particularly on the training of geometrical intuition and on acquiring the habit of functional thinking. The carefully prepared explanations accompanying the detailed program for the nine-year course show how these aims should guide the instruction at every step. The insistence on the idea of the functional relation can not be recommended too strongly to our writers of college text-books, from trigonometry to differential equations. But, as this report demands, it should even enter into the very elements of algebra and geometry.

It should be observed that the committee that prepared this report was not composed of mathematicians only; all branches of science taught in the secondary schools were represented in it; and all these branches received equally careful attention. While the portion of the report devoted

[2] See *Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht*, Vol. 36 (1905), pp. 533–580.

[3] *Loc. cit.*, pp. 543–545, 550–553.

to mathematics covers almost the whole range of the subject, from arithmetic to the elements of the calculus, required of our engineering students, there is nowhere any reference to students of engineering or to any other special class of students. I might, therefore, appear out of order in speaking of this report at the present occasion. But I wish to say most emphatically that, in my opinion, there is no special "mathematics for engineers"; nor is there any method of teaching mathematics, specially adapted to engineering students. If it is wrong to present mathematics in a form so abstract as to make it unintelligible to the student, it is just as wrong to present the results of mathematics in a form so concrete as to reduce the science to a mere art of performing certain mechanical operations, to make it, as the saying goes, a mere tool, and not a habit of thinking.

In conclusion allow me to say that I should be the last to advocate a remodeling of our institutions of learning on the German plan, or the French plan, or any other existing plan. But I believe that the time has come in this country when one or two years of general college study can be demanded as preparation for the professional engineering course, at least for those more able students who wish to obtain a thoroughly scientific preparation for their professional career. An opportunity should then be offered to students of engineering of scientific ability to extend their knowledge on the theoretical side.

ALEXANDER ZIWET
UNIVERSITY OF MICHIGAN

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## *THE BRITISH BUREAU OF SLEEPING SICKNESS*

THE British Colonial Office has issued the following statement:

At the instance of the late secretary of state for the colonies and with the cooperation of the government of the Sudan and the Royal Society, his majesty's government have decided to establish in London a bureau for the collection and general distribution of information with regard to sleeping sickness. The Royal Society will find accommodation for the bureau at Burlington House, and one fourth of the cost of up-keep will be borne by the Sudan government.

The bureau will be under the general control and direction of an honorary committee of management, appointed by and responsible to the secretary of state for the colonies. The committee will be composed of the following: Chairman, the Right Honorable Sir J. West-Ridgeway, G.C.B., who is also chairman of the advisory committee of the tropical diseases research fund; Sir Patrick Manson, M.D., K.C.M.G., F.R.S.; Sir Rubert Boyce, F.R.S.; Dr. Rose Bradford, F.R.S. (representing the Royal Society); Colonel D. Bruce, C.B., F.R.S.; Mr. E. A. Walrond Clarke (representing the foreign office); Mr. H. J. Read, C.M.G. (representing the colonial office), with Mr. R. Popham Lobb, of the colonial office, as secretary.

The main function of the bureau, which will be administered by a paid director, will be to collect from all sources information regarding sleeping sickness, to collate, condense, and, where necessary, translate this information, and to distribute it as widely and quickly as possible among those who are engaged in combating the disease. The publications of the bureau will be divided into two categories, viz., scientific publications intended for those who are engaged in research work or in carrying out medical administration in the infected districts, and publications of a less technical character for the use of government officials, missionaries and others, whose duties involve residence in those districts. One important piece of work will be the preparation of a map of the whole of tropical Africa, showing the distribution of the disease and of the different species of blood-sucking insects which are suspected of conveying it. A map of this kind showing, as it would, the extent to which the distribution of the disease coincides with the distribution of the different

species of insects, is expected to supply valuable information to scientific investigators and to give guidance to the different administrations, by indicating the lines of advance of the disease and the districts which require special protective measures. The duties of the director of the bureau will for the present be undertaken by Dr. A. G. Bagshawe, of the Uganda Medical Staff.

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### *BEAUPERTHUY ON MOSQUITO-BORN DISEASES*

Dr. Agramonte, in an article quoted from the Havana *Cronica Medico* by the *British Medical Journal,* calls attention to the pioneer work of Louis Daniel Beauperthuy, born in Guadeloupe in 1808. Writing in the *Gaceta Oficial de Cumanà* in May, 1853, Beauperthuy says:

To the work I undertook (health officer in a yellow fever epidemic in Cumanà) I brought the knowledge gained during fourteen years' microscopic observation of the blood and secretions in every type of fever. These observations were of great service to me in recognizing the cause of yellow fever and the fitting methods of combating this terrible malady. With regard to my investigations on the etiology of yellow fever I must abstain for the present from making them public. They form part of a prolonged study, the results of which are facts so novel and so far removed from all hitherto accepted doctrines that I ought not to publish them without adducing fuller evidence in support. Moreover, I am sending to the Académie de Paris a communication which contains a summary of the observations I have made up to the present, the object of which is to secure the priority of my discoveries concerning the cause of fevers in general. . . .

The affection known as yellow fever or black vomit is due to the same cause as that producing intermittent fever.

Yellow fever is in no way to be regarded as a contagious disease.

The disease develops itself . . . under conditions which favor the development of mosquitos.

The mosquito plunges its proboscis into the skin . . . and introduces a poison which has properties akin to that of snake venom. It softens the red blood corpuscles, causes their rupture . . . and facilitates the mixing of the coloring matter with the serum.

The agents of this yellow fever infection are of a considerable number of species, not all being of equally lethal character. *The zancudo bobo,* with legs striped with white, may be regarded as more or less the house-haunting kind. . . .

Remittent, intermittent and pernicious fevers, just like yellow fever, have as their cause an animal, or vegeto-animal virus, the introduction of which into the human body is brought about by inoculation.

Intermittent fevers are grave in proportion to the prevalence of mosquitos, and disappear or lose much of their severity in places which, by reason of their elevation, have few of these insects.

The expression "winged snakes" employed by Herodotus is peculiarly applicable to the mosquito and the result of its bite on the human organism.

Marshes do not communicate to the atmosphere anything more than humidity, and the small amount of hydrogen they give off does not cause in man the slightest indisposition in equatorial and intertropical regions renowned for their unhealthiness. Nor is it the putrescence of the water that makes it unhealthy, but the presence of mosquitos.

It was to the *Gaceta Oficial de Cumanà* that Beauperthuy seems to have written most fully, but he made more than one communication to the Académie des Sciences. One of these, dated from Cumanà, January 18, 1856, is entitled "Researches into the Cause of Asiatic Cholera and into that of Yellow Fever and Marsh Fever," and in this he says that as early as 1839 his investigations in unhealthy localities in South America had convinced him that the so-called marsh fevers were due to a vegeto-animal virus inoculated into man by mosquitos.

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### *SCIENTIFIC NOTES AND NEWS*

Oxford University has conferred its doctorate of science on Dr. F. Raymond, of the Hôpital de la Salpêtrière, professor in the University of Paris; J. J. Harris Teall, M.A., F.R.S., director of H.M. Geological Survey; and James Ward, ScD., fellow of Trinity and professor of mental philosophy in Cambridge University.

Dr. Birkeland, professor of physics at Christiana, has been given the honorary

degree of doctor of engineering by the Technological Institute of Dresden.

SIR GEORGE DARWIN, K.C.B., F.R.S., has been elected a foreign member of the Amsterdam Academy of Sciences.

SIR WILLIAM RAMSAY has been elected a foreign member of the Società italiana delle Scienze.

DR. MAX RUBNER, professor of hygiene at Berlin, has been awarded the Liebig gold medal by the Bavarian Academy of Sciences for his work in veterinary science.

THE twenty-fifth anniversary of the connection of Professor A. Ceccherelli with the surgical clinic at Parma, Italy, was celebrated on June 24. A "Festschrift" was presented by his friends and pupils, and two albums, with autographs of colleagues at home and abroad and a gold plaque.

DR. AUGUST SCHUBERG, associate professor of zoology at Heidelberg, has been appointed director of the laboratory for protozoa in the Berlin Bureau of Health.

DR. ADOLF MEYER, recently elected director of the psychiatric clinic of the Johns Hopkins University endowed by Mr. Henry Phipps, will shortly visit Europe with the architect of the new buildings to inspect foreign psychiatric clinics.

DR. J. H. MUSSER, Philadelphia, is chairman of the national committee for the United States of the sixteenth International Medical Congress, to be held in Buda-Pesth next year.

THE United States government will be represented at the fourth Latin-American Scientific Congress to be held at Santiago, Chili, next September by W. H. Holmes, Bureau of American Ethnology; Col. W. C. Gorgas, United States army; Professor Bernard Moses, University of California; Professor William B. Smith, Tulane; Professor Paul S. Reinsch, University of Wisconsin; Professor Leo S. Rowe, University of Pennsylvania; Professor William R. Shepherd, Columbia; Professor A. C. Coolidge, Harvard; and Professor Hiram Bingham, Yale.

As heretofore, there is this year at the summer session of Cornell University a series of lectures open to the public on Monday evenings through the session. These deal with the present problems in various sciences. The course was opened on July 6, by President Schurman, and other speakers in the course are Professors Nichols, Titchener and Dennis. On Wednesday evenings general lectures are given. Arrangements have been made for one by Professor Condra on the great irrigation projects of the government in the arid lands of the west, one by Mr. Charles W. Furlong on the remote regions of Patagonia, which he visited last winter, and another by Mr. Louis A. Fuertes on birds.

WE learn from *Nature* that the council of the Royal College of Surgeons has given permission to Dr. Elliot Smith and Dr. Wood Jones, of the Cairo Medical School, to carry out, in the museum of the college, an examination of a collection of material found during excavations in the Nile Valley. The material is representative of peoples inhabiting Nubia in ancient times, and is expected to throw light on their pathology and the results of their surgery. The Egyptian government has expressed its willingness to present the collection of specimens to the museum of the Royal College of Surgeons.

THE council of the Royal Society has awarded the Mackinnon studentships for the year 1908 as follows: One in physics to Mr. J. A. Crowther, of St. John's College, Cambridge, for an investigation of the passage through matter of the $\beta$ rays from radioactive substances; one in biology to Mr. D. Thoday, of Trinity College, Cambridge, for a research into the physiological condition of starvation in plants and its relation to the responsiveness of protoplasm to stimulation, especially to stimuli affecting respiration.

THE astronomical observatory and library founded in honor of Maria Mitchell, adjacent to her birthplace, on Nantucket, were formally dedicated on July 15.

WILLIAM DAMPIER, the navigator, has been commemorated by a tablet placed in the parish church of his native village, East Coker, Somersetshire. It takes the form of a marble slab, bearing a brass plate with inscription recounting Dampier's geographical

achievements, together with representations of the vessels and nautical instruments of his time. There is also a medallion portrait.

The German emperor has supported the medical and scientific men in Berlin in objecting to the form of the monument designed in honor of Virchow. It is not a statue of Virchow, but introduces as the chief group a symbolic representation of his lifework, in the form of a struggle between a giant and a fabulous beast, while on a pedestal a medallion portrait of Virchow is placed.

Dr. F. Noll, professor of botany at Halle, died on June 22 at the age of forty-nine years.

Dr. Oskar Liebreich, professor of pharmacology at Berlin, known for the introduction of hydrate of chloral in 1872 and for other important pharmacological work, has died at the age of seventy years.

The death is, also, announced of Professor Giuseppe Ponzio of the Royal Polytechnic Institute of Milan, an eminent Italian engineer.

The San Jacinto Valley in California will hereafter be known as the Cleveland National Forest. It has been so renamed by President Roosevelt in honor of the president under whose administration the first national forests were created. In 1897, in honor of Washington's one hundred and sixty-fifth birthday anniversary, and upon the recommendations of the National Academy of Sciences, President Cleveland created thirteen national forests, containing about 23,000,000 acres. The San Jacinto forest was one of the original thirteen so created.

The U. S. Civil Service Commission announces an examination on August 12–13, 1908, to fill a vacancy in the position of assistant, at $1,400 per annum, in the Naval Observatory, Washington.

Attempts are being made by the New Zealand government to preserve forms of the dominion's bird-life that are becoming rare. Mr. A. Hamilton, director of the Dominion Museum, in Wellington, has gone out into the forest-clad, mountainous districts of the north island to obtain specimens of the huia bird (*Heteralocha acutirostris*), which is one of the most interesting members of New Zealand's ancient avifauna. The huia lives under parliamentary protection, but as its white-tipped tail feathers, which were formerly worn by the Maoris to denote aristocratic rank, are much sought after and command a high price, a good deal of destruction takes place. The birds obtained by Mr. Hamilton will be placed on some of the island bird sanctuaries established by the government.

The sub-Antarctic scientific expedition, which set out from New Zealand some time ago, and spent several weeks on the Auckland and Campbell Islands, south of New Zealand, is preparing a series of reports, dealing with terrestrial magnetism, ichthyology, geology, bird and insect life, botany and other branches of science. The New Zealand government has made a grant of £500 to cover the cost of publication, which will be undertaken by the state printing office. The reports will be printed in one large illustrated volume, which will be issued next year.

The Italian government has appropriated $3,000 as its annual share in the expenses of the central office, which the International Public Health Conference last December agreed to organize, with headquarters at Paris.

The fifth congress of the International Association for Testing Materials is to be held at the beginning of September, 1909, in Copenhagen.

The annual *conversazione* of the Institution of Electrical Engineers, London, was held on June 25 at the Natural History Museum, South Kensington. Colonel R. E. Crompton, the president, and Mrs. Crompton, and the council of the institution received the guests, who numbered about 1,700.

The Royal Meteorological Society arranged at the recent show of the Royal Agricultural Society, held at Newcastle-on-Tyne from June 30 to July 4, a meteorological section in connection with the agricultural education and forestry exhibition. This included various patterns of self-recording and other instruments, as well as diagrams relating to rainfall,

temperature, sunshine, the influence of weather on crops, health, etc. A collection of photographs illustrating meteorological phenomena was also exhibited. A fully equipped climatological station, with the various instruments in position, was arranged in a railed-off enclosure outside the exhibition building; and an address on "Meteorology in Relation to Agriculture" was given each day by Mr. W. Marriott.

THE first biennial convocation of the grand chapter of Alpha Chi Sigma, the professional chemical society for students in American universities, met on June 27 at the University of Wisconsin. The official delegates representing the seven universities on the chapter roll are as follows: Alpha chapter, University of Wisconsin, F. P. Downing; Beta, University of Minnesota, O. O. Whited; Gamma, Case School of Applied Science, Karl W. Ketterer; Delta, University of Missouri, L. S. Palmer; Epsilon, University of Indiana, W. B. Jadden; Zeta, University of Illinois, E. J. Bartells; Eta, University of Colorado, Frank J. Petura. This is the only fraternity of the kind that is national in its character, and it has been remarkably successful since its organization at the University of Wisconsin in 1902. The purpose is to promote good fellowship and closer relations between those interested in chemistry as a profession.

THE United States National Museum has received as a gift from Mr. J. N. Léger, minister from Haiti to the United States, a case which contains models representing over a hundred different fruits of Haiti arranged for exhibition purposes. This collection of models of fruits and vegetables, which was exhibited at Jamestown, is probably the most complete series of its kind that has ever been prepared. The fruits of Haiti include many forms that are rarely seen in this country, and this set of models can not fail to be of interest. The following are the names of the most curious fruits of the island: cashew, ginger plant, mango, alligator pear, castor oil seed, custard apple, pomegranate, guava, tamarind, naseberry, and a large green bread fruit.

THE Sunday Society, which exists to obtain the opening of museums, art galleries, libraries, and gardens on Sundays, has, says *Nature*, been making attempts, though as yet unsuccessfully, to secure the opening on Sundays of the science and art collections at the Franco-British Exhibition. The experience gained during the last twelve years would appear to show that the Sunday opening of national museums and galleries has been greatly appreciated, and that there has been no abuse of the privilege. The last published returns show that in 1906 the number of Sunday visitors to the British Museum was 57,738, an average Sunday attendance of 1,110; at the Natural History Museum for the same year the corresponding numbers were 61,151 and 1,176. In 1905 the number of visitors to the Victoria and Albert Museum on Sundays was 93,005, an average Sunday attendance of 1,755; the corresponding numbers in the same year for the Bethnal Green Museum were 74,990 and 1,415.

ON May 23, as we learn from the London *Times*, took place the inaugural ceremony of the International Institute of Agriculture in the presence of his Majesty the King of Italy, who attended in state and formally opened the new building erected for the use of the permanent delegates. The Italian government was represented by seven ministers and the chief officers of state, while some 30 foreign delegates attended on behalf of the various countries which have promised their cooperation. Speeches were made by Signor Tittoni, the foreign minister, who welcomed the foreign delegates; by M. Vasconcellos, the Portuguese Minister, in reply, and by Senator Faina, who explained the history and aims of the institute. The foreign delegates were afterwards entertained at a dinner by the king in the Quirinal, at which there were present, among others, Sir Thomas Elliot (Great Britain), Sir Edward Buck (India), Mr. Rutherford (Canada), Mr. Taverner (Australia) and Boghos Nubar Pasha (Egypt). The new building is situated within the gardens of the Villa Borgese, on rising ground immediately upon the left of the main entrance. The

architect, Signor Passerini, may be congratulated on having devised an edifice which is worthy of its beautiful surroundings; also on having wisely spared, as far as was possible, the pine trees which once crowned the height and still almost conceal the new palace from view. The palace, which is the gift of the King of Italy, is of considerable size, and contains meeting rooms, reception rooms, and private rooms for the delegates resident in Rome. All the fittings are of the most complete, even luxurious, character, and no money has been spared to ensure comfort as well as convenience. Besides the palace itself, King Victor Emmanuel has generously endowed the institute with an income of £12,000 a year, which, added to the contributions of those countries which have joined in the scheme, will make a total of about £40,000 a year to defray its expenses. The international character of the institute is already complete; every nation has given its adhesion, and, with few exceptions, has appointed its delegates. There is no need to explain again the aims of the institute, which have already been fully set out in the columns of the *Times*. It owes its existence, first, to the imagination of an American, Mr. Lubin, who started the idea; secondly, to the initiative of the King of Italy, who brought his influence to bear in order to realize it. Three years have not yet elapsed since the conference assembled in Rome, June, 1905, at the king's invitation, and already the institute has taken an actual and material shape. The rapidity of its first growth is a good augury for its future success.

A COMMITTEE on the use of lead in the manufacture of earthenware and china has been appointed by the British home secretary. The committee is to consider the dangers attendant on the use of lead in pottery, and to report how far these can be obviated by improved appliances and methods in lead processes, by the limitation of the use of lead, by the substitution of harmless compounds for raw lead, or of other materials for lead, and by other means. The committee is also instructed to consider the danger and injury to health arising from dust or other causes in the manufacture of pottery, and the special rules regulating the decoration of earthenware and china. The members are: Mr. E. F. G. Hatch (chairman), Mr. A. Vernon Harcourt, F.R.S., Dr. George Reid, Mr. William Burton and Mr. Bernard Moore.

THE Ohio state legislature has passed the following resolutions:

WHEREAS, the health of the nation is of paramount importance, and "our national health is physically our greatest national asset" (President Roosevelt) and,

WHEREAS, in the growth of nations it inevitably happens that the people are massed in large centers, thereby, if uncontrolled, creating unsanitary conditions destructive of life and health, and,

WHEREAS, such conditions can be removed and prevented only by the intelligent care and oversight of public health officials endowed with broad powers and necessary means for action, and,

WHEREAS, in the prevention of diseases by the enforcement of health measures by local officials in both urban and rural districts adequate results can be obtained only when such measures are soundly based upon well substantiated facts and observations in relation to sanitation and hygiene, and,

WHEREAS, the United States government, in ways impossible for the state and municipality, may gather information and conduct research work to determine the causes of disease and the best measures for their prevention, and by cooperation with state and local authorities may promote the health of all the people, and,

WHEREAS, the President in his Provincetown speech expressed the hope "that there will be legislation increasing the power of the national government to deal with certain matters concerning the health of our people everywhere," therefore,

Be it *Resolved* by the General Assembly of the State of Ohio, that the Congress of the United States be, and it is hereby memorialized and urged, to create and establish a National Bureau of Health, and endow it with power and funds commensurate with the highly important duties with which it will necessarily be entrusted; and,

Be it further *Resolved*, that the senators and members of the House of Representatives from Ohio, in the congress of the United States, be, and they are hereby requested, to urge congress to adopt such legislation as may be necessary to secure the establishment of said proposed bureau of health.

*Resolved*, that the secretary of the state of Ohio transmit immediately upon the passage of this resolution a copy thereof to the Senate and the House of Representatives of the United States, and to each of the representatives of Ohio therein.

A PRELIMINARY report of the consumption of pulp wood and the amount of pulp manufactured last year has just been issued by the Bureau of the Census. The advance statement is made from the statistics collected by the Census Bureau in cooperation with the United States Forest Service. Many of the figures bring out interesting facts which show the rapid growth of the paper-making and allied industries during the last decade. Nearly four million cords of wood, in exact numbers 3,962,660 cords, were used in the United States in the manufacture of paper pulp last year, just twice as much as was used in 1899, the first year for which detailed figures were available. More than two and one half million tons of pulp were produced. The pulp mills used 300,000 more cords of wood in 1907 than in the previous year. The amount of spruce used was 68 per cent. of the total consumption of pulp wood, or 2,700,000 cords. The increased price of spruce has turned the attention of paper manufacturers to a number of other woods, hemlock ranking next, with 576,000 cords, or 14 per cent. of the total consumption. More than 9 per cent. was poplar, and the remainder consisted of relatively small amounts of pine, cottonwood, balsam and other woods. There was a marked increase last year in the importation of spruce, which has always been the most popular wood for pulp. For a number of years pulp manufacturers of this country have been heavily importing spruce from Canada, since the available supply of this wood in the north-central and New England states, where most of the pulp mills are located, is not equal to the demand. Figures show that the amount of this valuable pulp wood brought into this country was more than two and one half times as great in 1907 as in 1889. In 1907 the importations were larger than ever before, being 25 per cent. greater than in 1906. The spruce imports last year amounted to more than one third of the consumption of spruce pulp wood. Only a slightly greater amount of domestic spruce was used than in 1906. Large quantities of hemlock were used by the Wisconsin pulp mills, and the report shows that the Beaver State now ranks third in pulp production, New York and Maine ranking first and second, respectively. Poplar has been used for a long time in the manufacture of high-grade paper, but the supply of this wood is limited and the consumption of it has not increased rapidly. Wood pulp is usually made by either one of two general processes, mechanical or chemical. In the mechanical process the wood, after being cut into suitable sizes and barked, is held against revolving grindstones in a stream of water and thus reduced to pulp. In the chemical process the barked wood is reduced to chips and cooked in large digesters with chemicals which destroy the cementing material of the fibers and leave practically pure cellulose. This is then washed and screened to render it suitable for paper making. The chemicals ordinarily used are either bisulphite of lime or caustic soda. A little over half of the pulp manufactured last year was made by the sulphite process, and about one third by the mechanical process, the remainder being produced by the soda process. Much of the mechanical pulp, or ground wood, as it is commonly called, is used in the making of newspaper. It is never used alone in making white paper, but always mixed with some sulphite fiber to give the paper strength. A cord of wood ordinarily yields about one ton of mechanical pulp or about one half ton of chemical pulp.

PROFESSOR H. W. CONN, of Wesleyan University, has sent to the press the manuscript of a new bulletin of the State Geological Survey, "The Algæ of the Fresh Waters of Connecticut," as a companion to a previous bulletin, "The Protozoa of the Fresh Waters of Connecticut." Professor Conn was assisted in the work by Mrs. L. H. Webster, a former graduate student. The bulletin contains over 300 illustrations by the two authors and Harold J. Conn (Wesleyan 1908), son of Professor Conn.

More than seventeen million pounds (17,211,000) of metallic aluminum were consumed in this country during last year, according to Mr. W. C. Phalen, of the United States Geological Survey, whose statistical report on the production of aluminum and bauxite has just been published by the survey as an advance chapter from Mineral Resources of the United States, Calendar Year 1907. This is an increase of 2,301,000 pounds over the consumption in 1906. The great increase in domestic production that was predicted in the early part of 1907 was not realized, and the failure of the predictions is attributed by Mr. Phalen, in large part at least, to the falling off in demand toward the close of the year as a result of general business depression. The output of bauxite, which finds its most important use as raw material for the production of metallic aluminum, increased almost 30 per cent. in quantity and a little over 30 per cent. in value in 1907 as compared with the quantity and value of the output in 1906. In the earlier year 75,332 tons, valued at $368,311, were produced; in the later, 97,776 tons, valued at $480,330. Although Arkansas still leads in the total production, the output from Georgia, Alabama and Tennessee increased in 1907 over 50 per cent., as compared with an increase of perhaps 20 per cent. in Arkansas. Bauxite ore to the amount of 25,066 tons, valued at $93,208, was imported during the year, making the consumption of bauxite in 1907 amount to 122,842 tons, valued at $573,538. In addition to its use in the production of metallic aluminum, bauxite is in demand for the manufacture of aluminum salts, artificial abrasives (alundum) and bauxite brick. This last use is of very recent date. The chief value of the bricks lies in their resistance to the corrosive action of molten metal at high temperatures, and hence they find application in basic open-hearth steel furnaces, in furnaces for refining lead, in copper reverberatory furnaces, and in the linings of rotary Portland cement kilns.

The need for conserving the mineral fuels of the country for the use of future generations has been emphasized many times during the last few years, not only in numerous magazine and newspaper articles, but in a number of reports emanating from the government bureau especially charged with the investigation of the mineral resources of the national domain—the Geological Survey. The statements that the coal supply of the country is far from being inexhaustible, that the amount available is susceptible of measurement, and that no very long look into the future is required to see the end of the present known deposits are graphically supported by a map that has just been published by the Geological Survey. A somewhat similar map was issued by the survey in 1906, but the work of the geologists in the western coal fields in the last two years has added so much to the known extent of those fields that a new and revised edition has become necessary. The map now presented to the public is unique in several particulars. It not only shows the location and extent of the coal deposits of the United States, but also, by variation in color and depth of shading, the character of the coals in each of the great fields and the depth at which they occur beneath the surface. For the first time an attempt has been made to represent the coal in the deep basins, or "synclines," as the geologists term them, of the Rocky Mountain states, where there is every reason to suppose that coal exists, although it is so deeply covered by later sediments as to be accessible with great difficulty if at all. Other new features of the map are the explanation printed on the side margins, describing the character and geologic age of the coals, and the accompanying tables, which give estimates of the amount of coal originally present in the deposits, the quantity that has been removed, and the amount still available, subdivided into deposits easily reached and those accessible with difficulty.

## *UNIVERSITY AND EDUCATIONAL NEWS*

Under the Minnesota state law of 1865 certain swamp lands were set aside to be sold for the benefit of state institutions. The state constitutional amendment which was adopted in 1881 acted to repeal the law of 1865 and the law of 1907 was passed to make effective the plain intent of the constitutional amend-

ment of 1881. The fund from the sale of this land had grown to be $780,556.25 at the end of the fiscal year 1906. This fund must be kept intact and only its income apportioned for the benefit of the state institutions. One half of the interest, which now amounts to $62,145, goes to the common school fund and the balance to state institutions pro rata on the basis of the cost of maintenance. This brings into the university fund $16,542.92.

OWING to the contributions which have been made for the reendowment of Oxford University having reached a total of more than £100,000, the second munificent donation of £10,000 promised by Mr. W. W. Astor has now been received by Lord Curzon of Kedleston, the chairman of the fund.

THE report of the Cambridge University museums and lecture-rooms syndicate records a gift of £500, made by Mr. Frank Smart, for additional fittings in the museum of botany. The library in the department of physiology has been increased by many books formerly in the possession of Sir Michael Foster; the library of the medical school has also received many additions, including a large number of pamphlets and books presented by Sir T. Clifford Allbutt.

PREPARATIONS are being made to celebrate the four hundredth anniversary of the founding of the University of Madrid, which occurred October 18, 1508.

DR. DAVID FRANKLIN HOUSTON has resigned the presidency of the University of Texas, which he has held for the past three years, to accept the chancellorship of Washington University, St. Louis, vacant by the retirement of Dr. W. S. Chapin. Dr. Sidney E. Mezes, professor of philosophy at Texas since 1894 and for the past five years dean of the university faculty, was on July 6 elected president of the University of Texas by the board of regents.

MR. FRANK LEVERETT, geologist of the United States Geological Survey, has been appointed assistant professor of glacial geology at the University of Michigan. He will devote only a portion of his time to university work, retaining his position on the survey. Mr. R. C. Allen, A.M. (University of Wisconsin), lately in charge of the Badger mines of the Cobalt District, has been appointed instructor in economic geology.

THE vacancy caused by the resignation of Dr. L. J. Cole, at the Rhode Island Agricultural Experiment Station, has been filled by the appointment of Philip B. Hadley, Ph.D., of Brown University, as chief of the division of biology. The following appointments at the station have been made: J. Swett Irish, B.Sc., of the University of Maine, assistant in biology, and A. L. Whiting, B.Sc., of the Massachusetts Agricultural College, assistant in agronomy.

THE trustees of the Thomas S. Clarkson Memorial School of Technology have appointed to the chair of chemistry Mr. L. Kimball Russell, S.B. (Mass. Inst.), A.M. (Columbia). To the newly established chair of physics the trustees have appointed Mr. E. B. Wheeler, B.S. (Missouri), candidate for the doctorate of philosophy, Columbia University.

DR. JOHN CAMERON has been appointed lecturer on anatomy in the Medical School of the Middlesex Hospital, London.

DR. WÜLFING, of Kiel, has been called to the chair of mineralogy and geology at Heidelberg, vacant by the retirement of Professor Rosenbusch.

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## *DISCUSSION AND CORRESPONDENCE*

### A CONTINUOUS CALORIMETER

TO THE EDITOR OF SCIENCE: In the issue of SCIENCE of May 15 appeared a special article by H. T. Barnes, of McGill University, entitled, "A Simple Continuous Calorimeter for Students' Use." Permit me to call the attention of your readers to the description of similar apparatus appearing in "Electricity and Magnetism," by Francis E. Nipher, published by John L. Boland Book and Stationery Co., St. Louis, 1895.

The experiment as therein described has been for fifteen years in the hands of students at Washington University.

LINDLEY PYLE

WASHINGTON UNIVERSITY

## QUOTATIONS

### ACADEMIC CONTROL IN GERMANY

The German university world has been stirred to its depths by the sudden creation of a fourth professorship of economics at the University of Berlin, and the immediate appointment to it of a young teacher at the University of Kiel. For years past the three professorships of economics at Berlin have been held by Professors Wagner, Schmoller, and Sering—men of world-wide reputation, who have been assisted by four or five "extraordinary" professors and a swarm of docents. There was, therefore, not the slightest necessity, from the teaching point of view, of creating a new professorship. But early in this month the university authorities were astounded to receive from the Ministry of Education the notice that a new chair had been founded, and that Professor Ludwig Eernhard, thirty-two years of age, had been appointed to it. The ministry explained that, owing to certain circumstances requiring haste, there had been no time to sound the university authorities, as was the invariable custom; nor had it either consulted or received permission of the Prussian Diet, but had used for this purpose certain emergency funds given to it for an entirely different purpose. The real reason, it appears, is that Professor Bernhard has published a study of the Poles in Prussia which supported the government in its anti-Polish crusade. Having received a call from a South German university, he was about to accept it and give up his Polish studies. Merely that he might continue them, he was given a full professorship in the foremost German university. Naturally, the world of scholars is up in arms at this use of a great institution for purely political purposes.[1]—New York *Evening Post.*

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## SCIENTIFIC BOOKS

*Un problème de l'évolution.* La théorie de la récapitulation des formes ancestrales au cours de développement embryonnaire. (Loi biogénétique fondamentale de Haeckel.) Par L. Vialleton. Montpellier, Coulet et Fils. 8vo. 1908.

This volume is a characteristic French production in that it gives with rare skill a comprehensive and clear summary of a complex scientific problem. To the American reader it will seem strange that no mention is made of Louis Agassiz, the most celebrated of all the defenders of the theory of recapitulation; and it is to be regretted that the article by Adam Sedgwick, "On the Law of Development, known as 'Von Baer's Law,'" which was published in the *Quarterly Journal of Microscopical Science,* 1894, should have remained unknown to the author. None the less, the work is very excellent of its kind. It is based upon a series of lectures delivered a year ago before the students of philosophy at Montpellier. The author gives an introduction and historical review, which deals with Meckel, his predecessors and followers, a résumé which biologists will surely welcome. He then passes in a series of chapters, IV.–VIII., to the presentation and discussion of the evidence in the structure and development of vertebrates, for and against the theory of recapitulation. This is certainly very well done; the selection of examples is apt, and they are laid before the reader in such a way that he is brought gradually to a clear understanding of the necessary limitations which must be put upon the law of recapitulation. These chapters deserve especially to be recommended to the attention of teachers and students of general biology.

The last chapter is devoted to presenting the ideas of Oskar Hertwig, and is essentially a critical analysis of Hertwig's essay in the concluding volume of his "Handbook of Comparative Embryology." Here, I think, the author is somewhat at fault in attributing so much originality to Hertwig. For many years embryologists have been familiar not only with the law of recapitulation, but with the

[1] The philosophical faculty at Berlin has voted that, while it has no personal objection to Professor Bernhard, it does not approve his appointment, owing to the fact it was not consulted. Thereupon Professor Bernhard declined the offer of the ministry of education.—Ed.

limitations which must be put upon it. Thus, in my own "Laboratory Text-book of Embryology," published in 1903, pp. 41–43, is given a brief outline of the subject. It seemed to me then that the general opinion was well established, although at that time no single comprehensive essay had been written upon the subject. Hertwig's essay is most creditable, but most of the views he presents were certainly current among embryologists before he wrote. This emphasis of the importance of Hertwig's essay is a most amiable failure, and we may welcome a fresh example of international scientific courtesy, but a critic may be pardoned if he notes that that courtesy is somewhat exaggerated in its expression.

In conclusion, one may recommend Professor Vialleton's work to American readers very cordially. It is a sensible, competent and interesting presentation of a great biological problem, and unquestionably the best we have had.

CHARLES S. MINOT

*The Common Sense of the Milk Question.* By JOHN SPARGO.

This book is a layman's endeavor to provide for the average intelligent citizen a popular, easily understandable statement of the politico-social aspects of the milk problem. This being the case, it is unfortunate that the author has emphasized so strongly his opinion as to the cause of the decline of breast feeding and that he has so severely arraigned the public authorities for their supposed crimes of omission and commission with reference to the milk supply. The average reader will be too apt to accept the author's opinions without looking beyond them to determine the sufficiency or the insufficiency of the evidence upon which they are based.

It may be true, as Mr. Spargo holds, that physical disability on the part of the mother is responsible for the larger part of the cases of bottle feeding, but there is a very respectable opinion to the contrary. And so long as the question can not be answered with reasonable certainty and unanimity by the body of men best able to speak—the medical profession—it might have been better for a lay writer not to declare quite so positively concerning it. For many a mother may find in his teachings the very excuse she is longing for to justify her conscience in submitting her baby to the dangers of bottle feeding. Even admitting, however, that the decline of breast feeding is due to increasing frequency of physical incapacity on the part of the mother, it is not necessary to attribute the increase to racial degeneration; inadequacy of lacteal function in the individual, when it occurs, seems much more likely to be as yet the immediate result of the disuse of the mammary glands during the long period that now commonly ensues after their full anatomical development and before they are called into use, the result of late marriage and postponed child-bearing, rather than the result of racial deterioration.

Mr. Spargo should have submitted evidence to show "the dishonest connection between the manufacturers (of infants' artificial foods) and the health bureaus of the country" or else should have omitted the allegation of its existence. The records of births on file in the health offices of this country are commonly public records, and it bespeaks neither dishonestly nor graft on the part of the health officer if he refrains from denying to the citizen his right of access to such records, even though such a citizen be in the service of a manufacturer of one of the tabooed foods and desires to abstract for advertising purposes the names and addresses of the mothers of children recently born. The allegation, too, that "our civic authorities stand in the position of murderers and accessories to the murder of thousands of infants every year" is ill-advised, since it is not true. It seems remarkable that one who is endeavoring so earnestly as is Mr. Spargo to improve the milk supply should have overlooked the fact that the accomplishment of that end can not be furthered by holding up to public contumely officials who, as a class, are quite as sincere in their desire and quite as earnest in their effort to accomplish that result as is Mr.

Spargo himself, and many and possibly most of whom are doing all that can be done with the authority and money that the people have put at their command. What these men need, if they are to do efficient work, is more public sympathy and support, and more authority and more money wherewith to exercise it, and the publication of such statements as those quoted above will not help them to get any of these things.

With the author's working program no fault can be found: "Healthy herds, efficient inspection, insistence upon cleanliness and careful handling of the milk, municipal farms for providing public institutions, infants' milk depots for the sale of properly modified and pasteurized milk for babies, education of the mothers and the girls before they reach wifehood and motherhood." Too little consideration is given to the cost of producing and marketing milk, for after all it is reasonable to believe that milkmen will be found ready to provide just as good a product as the market demands, providing only that the market is reasonably steady and the market price yields a fare profit. The stress laid on the availability of the goat as a source of milk is unusual. The proper sphere of this animal seems to be, however, as a source of one family supply, so that the consumer can be in entire command of the situation and the milk, taken from the goat under ideal conditions, pass promptly from the udder of the animal to the stomach of the child. But with the prevalence of apartment house life, and with the backyard of the dwelling contracted almost to the vanishing point, there are serious difficulties in the way of introducing goats into the domestic establishment. As a competitor to the cow in the production of the general milk supply the goat does not need to be seriously considered.

The author has followed the common practise of adopting infant mortality as an index to the character of the milk supply. No death rate, however, for infants under one year of age, or for children over one and under five, is of material value unless calculated on the basis of the population of corresponding age, and too commonly no such basis is available. No general death rate for infants is of value as an index to the efficiency of milk control, since it is based in part on the deaths of infants due to difficult labor, premature delivery and other causes to which the character of the milk supply is in no way related, and is influenced by variations in the numbers of deaths from these causes. And while the death rate from diarrhœal diseases among children under one or under two years of age possibly forms the best basis for estimating the results of the improvement of the milk supply, the number of deaths from such diseases is so influenced by atmospheric temperature and humidity that a full and accurate knowledge of such conditions is necessary when interpreting such death rates unless the figures relate to periods of time of such considerable duration as to reduce to a minimum the effect of these factors.

It is to be hoped that when another edition of this book is published a more convenient system of references to authors consulted will be adopted. A less diffuse style and possibly the concentration of attention on fewer subjects would probably render the book of more interest and value to the general reader. The fact that a layman should write a book on the milk question for lay readers and that a publisher should expect to find a sale for it is a hopeful sign of the times and augurs well for the early solution of the problem, for people themselves will eventually have to settle all questions concerning it, either through commercial readjustments or through force of law, or probably through both, and the mere official can do only what the people authorize and empower him to do.

Wm. Creighton Woodward
Washington, D. C.

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## *SCIENTIFIC JOURNALS AND ARTICLES*

The June number (volume 14, number 9) of the *Bulletin of the American Mathematical Society* contains the following papers: Report

of the April meeting of the society, by F. N. Cole; report of the April meeting of the Chicago Section, by H. E. Slaught; In Memoriam Heinrich Maschke; "Criteria for the Irreducibility of a Reciprocal Equation," by L. E. Dickson; "A New Graphical Method for Quaternions," by J. B. Shaw; "Logic and the Continuum," by E. B. Wilson; Shorter Notices (Picard's "Développement de l'Analyse and La Science moderne," by E. B. Wilson; Mathew's "Algebraic Equations," by F. Cajori; Bertini's "Geometria Proiettiva degli Iperspazi," by C. H. Sisam; Staude's "Analytische Geometrie des Punktes, der geraden Linie und der Ebene," by G. N. Bauer; Shepard's "Strength of Materials," by E. W. Ponzer; Hering's "200-jähriges Jubiläum der Dampfmaschine," by F. Cajori); Notes; New Publications.

THE July number of the *Bulletin* (concluding volume 14) contains: "The Inverse of Meusnier's Theorem," by Edward Kasner; "On the Distance from a Point to a Surface," by Paul Saurel; "On the Solution of Algebraic Equations in Infinite Series," by P. A. Lambert; "The Deduction of the Electrostatic Equations by the Calculus of Variations," by A. C. Lunn; "The Fourth International Congress of Mathematicians," by C. L. E. Moore; Shorter Notices ("Encyklopädie der Elementar-Mathematik," Bande 2–3, by H. S. White; Lebesgue's "Leçons sur l'Intégration et la Recherche des Fonctions Primitives," by D. R. Curtiss); Notes; New Publications; Seventeenth Annual List of Papers read before the Society and subsequently published; Index of Volume.

AT the sitting of the Paris Academy of Sciences on June 22, according to a report, M. Poincaré read a note from M. Jean Becquerel on the nature of positive electricity and the existence of positive electrons which have been found in a Crookes tube. Dr. Salmon, of the Pasteur Institute, announced that sleeping sickness had been cured in monkeys by means of a form of atoxyl. MM. Beorges and Gustave Laudet gave particulars of their success in photographing sounds. Those photographs are so clear that they permit of a study of sound far more precise than any hitherto known. The most delicate peculiarities of the voice, such as lisping, and even breathing, are produced with the greatest distinctness. The MM. Laudet, who have been pursuing those inquiries since 1905, when they first communicated their ideas to the Academy of Sciences, have been induced to give the present account of their success owing to the recent communication on the same subject by M. Devaux Charbonnel. The MM. Laudet, instead of having recourse to electricity, like M. Devaux Charbonnel, have employed a purely mechanical and direct means for securing the desired record.

## *SPECIAL ARTICLES*

### OBSERVATIONS ON CHANGE OF SEX IN CARICA PAPAYA

WHILE change of sex among the phanerogams is not unknown yet it is of such rare occurrence that any well-demonstrated instances as those shown by the Caricas under observation are worthy of careful study. This is especially true when that change can be brought about by cultural methods as seems to be clearly proved in the present instance.

*Carica papaya* is a tropical, rapidly growing tree-like form belonging to the Passifloreæ family. As found in Porto Rico it is distinctively diœcious, the monœcious form being very rare except when produced as were the ones under observation. The tree is non-branching, but will readily develop lateral buds if the terminal bud is destroyed.

The staminate trees bear the flowers in dense, dichotomously branched head-like groups on a very long helicoid dichotomous branched peduncle. The flowers in each group on the peduncle develop successively, continuing over a long period of time, so that there is no time during the year when flowers are not shedding pollen. The pistillate tree bears axillary flowers of a very different form from the staminate. The pistillate flowers are born in an unbranched peduncle and vary in number from one to five or even more; usually three. Of these only one, with rare exceptions, sets fruit. It is said that the flowers

are sometimes perfect, but such have not come under my notice as yet.

The fruit varies in form from oval to a distinctively necked pear shape and in weight from three pounds to ten pounds or even more. The fruit in some varieties is very delicious and has many medicinal properties ascribed to it, so that the plant is of enough value economically aside from its botanical interest to be worthy of careful study.

The change of sex in the first tree noted was brought about accidentally. A staminate tree of some age had its terminal bud accidentally injured. The staminate flower clusters produced shortly afterwards contained pistillate flowers in the terminal group. These flowers set and developed good-sized fruits. When mature they had all the characteristics of normal fruits except that the fruits were not quite so well filled out, having a somewhat wrinkled appearance. The seeds are smaller than the normal seeds but seem to be normal in other respects. Time has not been sufficient to test their germinating power. The clusters later developing also contain pistillate flowers in the same position in the cluster as the first one, and now and then a cluster will contain two and even three of these fertile flowers, each one producing fruit.

On observing this peculiarity, investigations were begun to find the cause. Inquiry of the natives brought out the theory that the removal of the terminal bud in the new of the moon would usually cause this transformation. Other trees growing on the grounds were at once set aside for experimental purposes and the tops were removed at different phases of the moon to disprove the moon's having any effect and also to show, if possible, what were the necessary conditions, if any, outside of the mere removal of the terminal bud. Thus far it is clearly shown that the removal of the terminal bud does cause the change, but also that some other condition is necessary, as only a part of those thus treated have thus far developed any pistillate flowers. The moon's phase does not appear to have any control, though, strange to say, those treated at a fairly definitely recurring period are the ones that show change. It is possible that the plant has definite short cyclic periods of growth and that it is necessary to remove the tip at some definite phase of this cycle in order to produce the development of fertile flowers. If this be true and this cycle should accidentally coincide fairly well with the moon's phases, the belief in moon influence would naturally arise.

This view of an approximately monthly periodic cycle of growth has several things to support it. The chief of these is found in the continuous development of flowers and fruit. At no time during the year were the trees under observation without both flower and fruit. On the other hand, there are times when growth is more rapid, more flowers are developed and the terminal nodes elongate much more rapidly. The exact time of these periods has not yet been determined definitely, but data is being collected.

The habit of the plant is being closely studied to determine the characteristics of each change and at what point in this growth the tips must be removed to produce the changes under discussion. It is possible that the power to produce pistillate flowers is inherent in the plant, being dormant unless some shock is given to destroy the equilibrium of the growth forces. This inherent quality is indicated by the fact that in some countries the plants are sometimes found naturally monœcious.[1]

It may also be that certain varieties are monœcious. That there are variations in the plants is true, as noted under forms of fruits, but thus far no variation has been observed that was definite enough or of well enough fixed characters to warrant a well-defined division into varieties.

I recognize that as yet but little has been definitely settled and that the questions involved open up a wide field for investigation, but I present the facts, thinking they will be of interest and hoping that any discussion caused by them will bring out points that will aid in future investigations.

M. J. Iorns

Mayaguez, Porto Rico

[1] "Dictionary of Economic Products of India," Watt, Vol. II.

### OBSERVATIONS ON MEDICAGO LUPULINA L.

OWING to the occasional adulteration of alfalfa seed with yellow trefoil, *Medicago lupulina,* this plant is of considerable interest to alfalfa growers in the eastern states. It is encouraging to note that such adulteration is less common than formerly. Of 491 samples of alfalfa seed examined by the writer at the New York Experiment Station during the past eighteen months, only seven showed evidence of adulteration with yellow trefoil.

In botanical works *Medicago lupulina* is sometimes described as an annual and sometimes as "annual or biennial." Careful observation has shown that in alfalfa fields in New York it is regularly a biennial. Even when the seed is sown in spring only occasional plants blossom and seed the first year. The great majority do not bloom until the second year in the latter part of May, shortly before the first cutting of alfalfa. At this time the plants are very conspicuous because of their yellow blossoms; but they do not reappear in subsequent cuttings of the alfalfa.

That the plants actually do live over winter is proved by the results of the following experiment: On March 29, 1907, nine plants suspected of being *M. lupulina* were transplanted into the station greenhouse. Six of these were taken from an alfalfa field and three from a lawn on the station grounds. They all blossomed and proved to be as suspected.

Except when the two plants are in bloom, *M. lupulina* so closely resembles alfalfa, *M. sativa,* that the two species are distinguished with difficulty. This is especially true in the early stages of growth. The writer has sought unsuccessfully for morphological or anatomical characters by means of which the two species may be separated with ease and certainty. In early spring the most reliable characters by which the two species may be separated are, (1) the habit of growth of the crown and (2) the character of the root system. The crown of *M. lupulina* is spreading, very similar to that of red clover, and the stems are procumbent; while the crown of alfalfa is upright in habit. The root systems offer a more striking difference. Alfalfa has a large tap-root with very few side roots. *M. lupulina* has a small tap-root nearly concealed in a mass of fibrous side roots.

In conclusion, it may be of interest to note the finding of a *M. lupulina* seedling having three cotyledons.

G. T. FRENCH
NEW YORK EXPERIMENT STATION,
GENEVA, NEW YORK

## SOCIETIES AND ACADEMIES

### THE GEOLOGICAL SOCIETY OF WASHINGTON

AT the 207th meeting of the society, on May 27, Mr. F. E. Matthes discussed informally "Refusion of Cinders by Camp Fires on San Francisco Mountains, Arizona." Mr. L. D. Burling also discussed briefly "Colored Photography in Geology."

*Regular Program*

*The Coalinga, California, Oil Field:* Mr. RALPH ARNOLD and Mr. ROBERT ANDERSON.

The Coalinga District is situated on the eastern flank of the Diablo Range, along the border of the central valley of California. This flank of the range is formed of an eastward dipping monocline that exposes the Franciscan (probably Jurassic) in the axis of the range and above this about 26,000 feet of strata representing a considerable portion of the time up to the middle Pleistocene. There are at least 12,000 feet of Cretaceous, including lower and upper Cretaceous, with a probable unconformity between, and 14,000 feet of Tertiary and Quaternary beds composing six mutually unconformable formations. These belong to the Eocene, lower Miocene, upper Miocene, Pliocene and lower Pleistocene. The youngest formation that has undergone folding comprises a thickness of at least 2,500 feet of unconsolidated coarse and fine sediments belonging to the Pliocene and lower Pleistocene, and has been correlated with the Paso Robles formation of the Salinas Valley. It is of freshwater origin at the base and in part marine above, but is thought to have originated in large measure subaerially as a filling in the Great Valley of California. Great orogenic movements took place in the Pleistocene and in places lifted the deposits forming the floor of the central valley into steeply dipping folds. These folds are topographic as well as structural arches and afford a rare instance of the preservation of the original domes due to warping of the surface.

The petroleum occurs in beds and lenses of sand and gravel in the Eocene, lower Miocene

and upper Miocene formations. The petroleum from the Eocene varies in gravity from 20° to 42° Baumé and the production is usually light, varying from 4 to 75 barrels per day per well. The lower Miocene oil sands are the most important in the field, yielding oil of 14° to 31° Baumé. Individual wells produce as high as 3,000 barrels a day from the lower Miocene sands. The upper Miocene is petroliferous in the western part of the field, yielding oil of from 14° to 22° Baumé. Wells penetrating this formation seldom yield more than 600 or 800 barrels a day.

Water occurs in the formation above the oil sands and in some instances sulphur water is interbedded with the petroliferous strata. Little "bottom" or "edge" water has been encountered in the field. The oil is believed to be derived from the organic materials in the Eocene shale. There are nearly 400 productive wells in the field, these varying in depth from about 600 to over 3,000 feet. The production for 1906 was 7,991,039 barrels. The product is marketed by rail and through two long-distance pipe lines, much of it being refined.

*Laramie Formation:* Whitman Cross.

It has long been known that the Laramie of King and Hayden has been found to consist of two parts, a lower portion, corresponding to the original definition by King, which is conformable with the underlying Cretaceous section, and an upper portion, separated from the lower by a great unconformity and stratigraphic break in several localities. In earlier discussions of this question the author proposed to restrict the use of the term Laramie to such beds as constitute the upper conformable part of the Cretaceous section and to apply the term "Post-Laramie" in a tentative way to the group of formations separated from the Laramie by unconformity or stratigraphic break.

It has recently been ascertained by A. C. Veatch and others that the long-known formation at Carbon, Wyoming, on the Laramie Plains, is distinctly unconformable upon marine Cretaceous, no true Laramie beds being present at the best known exposures. Governed by the idea that the Carbon section is to be regarded as a type section of the Laramie, as defined by King, Mr. Veatch has proposed to restrict the term Laramie to the formations above the stratigraphic break up to the Fort Union formation. There are thus two directly opposing propositions for the use of the term Laramie. It is claimed by Mr. Cross that the term Laramie was not originally proposed especially for strata of southern Wyoming, but as a practical synonym for the term lignitic, and embraced formations known in many places in Montana, Wyoming, Colorado and New Mexico. The definition of Laramie by King mentions no type section and lays emphasis repeatedly upon the conformity of the Laramie with the underlying Cretaceous section. The Laramie was supposed by King to end with the Rocky Mountain revolution, which he assumed to take place preceding the Wasatch epoch. Mr. Cross repeats the proposition previously made to restrict the use of Laramie in accordance with the fundamental relations specified in the original definition, rather than to correspond with the local conditions which exist in the Carbon section.

For the various local formations separated from the Laramie, as thus defined, by unconformity or stratigraphic break, and older than the Fort Union beds, Mr. Cross proposes that a new term should be adopted.

Among the formations to be referred to the new group are the Arapahoe, Denver, Middle Park, Animas, and other local deposits of Colorado; certain beds of Carbon, Evanston and the Converse County Ceratops beds of Wyoming; the Livingston and Hell Creek beds of Montana. Certain features of stratigraphy and paleontology were considered and their bearing upon the assignment of certain beds to the Laramie or to the new group in certain cases discussed.

The assignment of the group to the Eocene rather than to the uppermost Cretaceous is advocated by Mr. Cross on the ground that such a division is particularly appropriate viewed from the standpoint of historical geology. The paleontological evidence is not believed to require the assignment of this group to the Cretaceous, and, indeed, much of the evidence is conceived to be in favor of the reference proposed.

Ralph Arnold,
*Secretary*

## The American Chemical Society. New York Section

The ninth regular meeting of the session of 1907–8 was held at the Chemist's Club, on Friday evening, June 5.

Professor Charles F. Chandler addressed the section on "Silk: Natural and Artificial." The lecture was illustrated by stereopticon and by numerous samples of raw and finished silk products.

C. M. Joyce,
*Secretary*